EDITORIAL

ELECTRIC SMELTING OF IRON ORES IN CANADA.

A Report by Dr. Alfred Stansfield on the "Commercial Feasibility of the Electric Smelting of Iron Ores in British Columbia' has recently been made public, and we print in this issue a condensed summary of the report containing the conclusions arrived at.

Attempts have been made, from time to time, to establish an iron smelting industry in British Columbia, and in view of the success that has attended the electric smelting of iron ores in Sweden, it appeared reasonable to expect that similar results would follow the establishment of this process in British Columbia.

Electric Iron Smelting requires a supply of good ore, an abundance of cheap power and an ample supply of charcoal or other form of carbon. British Columbia, like Sweden, has deposits of magnetite iron ore, and has abundant water power and timber from which charcoal can be made. When Dr. Stansfield began his investigation, last June, it appeared that electric power could be purchased at a fairly reasonable price which would have permitted the establishment of an electric smelting plant on a commercial basis, but the price finally asked by one of the Electric Power companies was so high as to render impossible the electric smelting of iron ores under present conditions. Now that the war is over it may become possible, once more, to undertake development work, and a water power may be developed cheaply enough to enable electric ore smelting to be carried on at a profit. In the meantime there is a possibility that certain technical improvements may be made that will lower, materially the cost of making electric furnace pig iron, and in that case the electric smelting of iron ores may become commercially possible in a number of localities where today it would be out of the question.

In Sweden, electric smelting is successful because the product is a pure variety of white pig iron which commands a high price. In British Columbia there is scarcely any market for such iron, the demand being for ordinary grades of foundry iron, and the possibility of electric smelting in that Province depended on the high price that obtains there for foundry iron.

The electric furnace is seldom an economical appliance for the production of ordinary foundry iron, but it has important advantages to offer in the production of certain varieties of pure pig iron, as well as in smelting ores that are not easily treated in the blast furnace. There are probably a number of localities in Canada where electric iron smelting can be undertaken with profit—particularly if the process can be made a little more economical.

IRON AND STEEL SECTION OF THE CANADIAN MINING INSTITUTE.

In February and March of last year, a number of Iron and Steel men met in Montreal to arrange for an organization of the Iron and Steel industries in Canada. After some discussion it was decided that this organization could be carried into effect most suitably by the formation of an Iron and Steel Section of the Canadian Mining Institute. The formation of this Section was formally sanctioned at the Annual Meeting of the Institute, and the relation between the Section and the Institute was arranged at a meeting between the Council of the Institute and the executive of the Section. A representative executive committee had by that time been arranged and Dr. Alfred Stansfield, who had been identified with the movement from its inception, agreed to act as organizing secretary until the regular officials could be appointed. Shortly after this, Dr. Stansfield was appointed to make a report on electric smelting in British Columbia and was consequently unable to give much attention to the Iron and Steel Section. It was intended to hold the inaugural meeting of the Section in Hamilton or some other city in Ontario, and Mr. Robert Hobson had undertaken to assist personally in arranging such a meeting. The influenza epidemic, in the autumn, rendered this meeting impossible, and the first meeting of the Section will therefore be held as part of the Annual Meeting of the Canadian Mining Institute, which is to take place in Montreal from the 5th to the 7th of March. At that meeting, in addition to the reading of papers dealing with the iron and steel industry, the policy of the Section will be discussed and officials will be appointed. In view of the importance of the work to be undertaken, it is essential that a permanent secretary shall be employed who can devote a large part of his time to the work of the Section. We take this opportunity of urging as many as possible of the iron and steel men throughout Canada to attend the inaugural meeting and thus to give their support to the new organization.

While we cannot predict in detail the policy of the Iron and Steel Section, we may say that meetings will be held at which those engaged in the industry may get to know one another, may learn to appreciate the difficulties of those in other branches of the industry, and may gain by interchange of experience. It is also intended that the Section shall provide a central secretarial office for the collection and distribution of information bearing on the iron and steel industry, and, in course of time, for representing the industry at Ottawa, whenever matters affecting the industry are under discussion.

The following are some of the subjects that have been suggested for discussion at the annual meeting, and Dr. Stansfield will be very glad to hear from any who are willing to write papers or join in the discussion of these or other suitable subjects.

Suggested Subjects for Papers at Annual Meeting.

(1) Development of the Iron and Steel Trade of Canada during the War;

(2) Re-adjustment of the Iron and Steel Trade under Peace Conditions;

(3) Requirements of Iron and Steel in Canada at the Present Time, for Railway, Shipbuilding, etc.;

(4) Employment of Returned Soldiers and Munition Workers in the Iron and Steel Industries;

(5) The Condition of Labour as Regards Rates of Pay, Strikes and Control of Industries;

(6) Prices of Raw Materials and Finished Products and Changes in these following the War; Dependence of these Prices on the Rate of Pay of Labor;

(7) Technical and General Education of the Working Classes;

(9) The Educational Effect of the War on the Iron and Steel Industries of Canada;

(10) Supplies of Iron Ore in Canada;

(11) The Fuel Situation in Canada.

MOLYBDENUM.

The name "Molybdenum" is derived from the ancient word molybdaena and was applied to galena and other lead compounds by the Greeks and Romans. It was considered identical with graphite until 1778 when the Swedish chemist Scheele demonstrated that it yielded a "white earth" on being oxidized with nitric acid, while graphite did not. By subsequent work he established the fact that the mineral was a native sulphide. The chemist Hjelm succeeded in isolating the metal by using the trioxide for its production; this method was to expose the latter to a full white heat in a crucible lined with charcoal. By such means he effected its reduction to the powdered form, but could never fuse the latter into a metallic button for no means was then known that could produce the necessary temperature. In 1893 Moissan, the eminent French chemist succeeded by applying the heat of an electric furnace to a mixture of the dioxide and carbon. In appearance metallic molybdenum is a silver white metal of atomic weight 95.9 and specific gravity of 8.6. It remains unchanged in air and only combines with oxygen when heated to low redness. Aqua regia will readily dissolve it, but hydrochloric and dilute sulphuric acid are unable to produce any reaction. Molybdenum forms a most remarkable compound with steel, and an even more remarkable one if nickel also be present. Experiments have found the high fusing point (about 2000° C.) of molybdenum liable to cause difficulty whilst the original procedure of applying it in powdered form has led to repeated disappointments. This is accounted for by the fact that the finely divided metal oxidizes readily when added to fused steel. So marked has this been that in many cases where powdered molybdenum has been added it has been quite impossible to trace the presence of the metal in the steel.

Although many metallurgists were favorably inclined towards the use of molybdenum it was somewhat difficult to obtain a reasonable supply prior to the opening up of deposits in Colorado and Oregon; obtaining molybdenite from middle Europe, through the assistance of agents, was a prohibitive proposition. Krupp, the steel maker of Essen, has for some years been a ready buyer of large quantities of molbydenite which have been utilized in the manufacture of special high grade steels. In broad terms the influence of molybdenum is similar to that of tungsten, but more intense, from a hardening point of view, 1 per cent of molybdenum will have about the same hardening effect as 2 per cent of tungsten. Samples taken from the inside of German guns have demonstrated that a lining containing 6 per cent of molybdenum had been used, presumably to increase resistance to erosion. The use of molybdenum has been objected to in some quarters and various reasons given to account for this disinclination to make use of so valuable an alloying element. A close examination of these objections seems to indicate an uncertainty as to its use, and the results upon the physical characteristics of the steel produced. It has been stated that after several reheatings the molybdenum disappears from the outer layers of steel, in other words the volatile constituent escaped from the surface. If this is correct then the molybdenum becomes oxidized and volatilized, but for this waste to penetrate to any appreciable depth implies either that the molybdenum moves through the heated steel to reach the oxygen of the air, or, which is far more likely, the oxygen of the air penetrates the steel, reaching the molybenum and oxidizing it, after which the volatile oxide escapes from the steel. In using molybdenum ferro-alloys with a molbdenum content of 50, 70, 75, or 85 per cent are available and should invariably be applied to the steel in an iron tube. Ferro-molybdenum steel is greatly improved by the presence of certain percentages of nickel, and the value of this ferro-nickel-molybdenum steel is very generally acknowledged, and is principally used for the manufacture of forgings, guns, rifle barrels, boiler plates, and shells. Molybdenum increases the elongation of carbon steel considerably, very much more so than nickel alone. Common practice is to make the molybdenum-nickel steel contain about 0.25 per cent molybdenum and by so doing the elongation may be increased from 4 to 35 per cent. Such a marked increase in elongation is of the greatest importance for wire drawing, and the percentage of molybdenum may be increased to 1 per cent where the metal is to be used for this purpose. Many well known brands of high-speed steels contain from 0.5 to 5 per cent of this element. Now that the time has arrived for the most intensive development of Canada's natural resources we look for further activity in connection with her molybdenite deposits. Some of these are producing, others can readily be placed upon a producing basis, and others, although showing good indications, still require further prospecting and opening up. The production of ferro-molybdenum alloys is an established industry and we consider it would be advisable for

some of our foundries to devote attention to the use of this element both in connection with straight carbon steels and high speed steels; the field is wide and successful development should be satisfactorily remunerative.

AMERICAN STEEL TREATERS' SOCIETY.

It is an undecided question whether metallurgical discoveries or a fuller knowledge of heat treatment can claim the greater credit for the improved physical characteristics of modern steel and we are glad to draw our readers attention to the inauguration of the "American Steel Treaters' Society." From a perusal of the first journal of this new organization enough can be gathered to justify congratulations for all those identified with the venture. With headquarters at Chicago, a representative board of directors, and well known men holding executive positions, a progressive and ambitious programme is outlined. A personal note is prominently printed and is at once a catch phrase and an appeal for members: "If you know it all, we need you. If you don't know it all we can help you." This constitutes a comprehensive claim upon all who are in any way concerned with the production, fabrication, heat treatment, and use of steel, and from such an army a satisfactory membership roll should easily be obtained. According to the suggested scheme branch sections, or Chapters, will be formed in all the more important steel producing centres and by this arrangement local interest and local conditions will both receive consideration. Associate editors will be located in different parts of the country and will keep the members in touch with movements and developments that are being made in the various localities. The detailed objects of the Society were all enumerated in the first number of the journal, published in October of last year, and these form a direct appeal to all those engaged in the manufacture, working, or heat treating of steel. The later numbers of the journal are filled with interesting, instructive and valuable matter, written by men with acknowled reputations in the art of heat treatment. The nation seeking to hold its own during the coming years of commercial warfare has to acknowledge certain fundamental principles, including the abolition of all waste, the simplifying of every process incidental to the conversion of raw materials into finished products; and to achieving the best possible results from such finished products. These ends can only be secured by education, using the word with its widest possible meaning, and a society inaugurated to study the phenomena of the thermal treatment of steel is well calculated to exert a beneficial influence in this desirable direction. We hope, from time to time, to be able to publish some of the papers, with the discussions thereon, that will appear in the transactions of this society.

The first number of the second volume of the Proceedings of the Steel Treating Research Society contains amongst other interesting papers one devoted to the "Effects of Phosphorus in Soft Acid and Basic Open Hearth Steels." The author, Mr. J. G. Unger, carried out certain investigations along these lines and having shown the nature and scope of his experiments proceeds to detail his conclusions. Twelve ingots from the same heat of acid steel, and fifteen from the same heat of Basic open-hearth steel, or 84 tons in all were used in this experiment. After the first three ingots of Basic steel had been poured sufficient 17% ferro-phosphorus was added during the pouring of the next three ingots to increase the phosphorus to .030%. To the following three ingots the addition was increased to show a phosphorus content of .055%, the next three to .085%, and the next to .110%. The same method was adopted in the ingot additions to the acid steel, excepting that only three sets of three ingots each, had additions of ferro-phosphorus made to them, as the original phosphorus in the steel was higher to begin with. The composition of the acid steel was

C.	Mn.	S.	Si.	Cu.
.12	.36	.037	.022	.012

with a phosphorus content of .032; .058; .085 and .015. That of the basic was

C.	Mn.	S.	Si.	Cu.
.12	.36	.036	.020	.014

with a phosphorus content of .008; .030; .052; .080 and .110. The detailed analysis was in each case from ladle sample. The author then follows these steels through all the usual operations, gives the results of tests, shows into what forms the metal was fabricated, and finally summarizes his conclusions. From these it would appear that increased phosphorus only indicated increased hardness, that in soft steels .01% of phosphorus was equivalent to an increase of about 850 lbs. tensile strength per square inch, which is practically the same figure as would be obtained if the carbon was increased by .01%. Within limits the influence of phosphorus could be nullified in soft, or low carbon steels, provided the carbon content was lowered to compensate for the increased hardness due to the phosphorus. In next months Iron and Steel we hope to be able to return to this paper for the purpose of analyzing some of the figures and results, and of comparing the latter with those of other writers.

Another interesting paper is included, in this publication, on the "Cause and Mechanism of Steel Failures." The modern tendency to trace back and scientifically, discover the cause of failures is well illustrated by the author, who carries his arguments from defective material to wrongly designed or proportioned parts, to defective workmanship, to a failing

to select the most suitable material, and to a want of knowledge of the physical structure of the steel. This paper contains a mass of practical information, well presented, and should be studied by all who are in anyway interested in securing maximum physical results from a minimum section of steel.

Electric Smelting of Iron Ores in British Columbia

A report by Dr. Alfred Stansfield on "The Commercial Feasibility of the Electric Iron Smelting of Iron Ores in British Columbia" has now been made public. The report is very elaborate, and has been divided for convenience into a number of chapters or appendices, each dealing in detail with one branch of the subject. The conclusions arrived at have been presented as concisely as possible in the condensed report which we print herewith. We omit however the introductory letters and account of the investigation. Dr. Stansfield visited British Columbia and California last summer in the preparation of the report which was completed before the termination of the war.

INTRODUCTION TO THE REPORT.

The object of this investigation and report is to determine the commercial feasibility of smelting electrically the magnetite ores of British Columbia.

For this purpose I obtained information with regard to the supply of iron ores, electrical power, charcoal, labour and other necessaries.

Early in the investigation it appeared that electric power might be obtained at such a price that electric smelting by the methods now in use would be commercially possible. I therefore investigated and discussed carefully the type of furnace and design of plant that would best suit the local requirements, and prepared estimates for the cost of such a plant and of making pig iron on a scale determined by the present requirements of the Province. It now appears that electric power cannot, at present, be obtained at prices that will permit of the use of the usual electric smelting methods; but I am presenting the results of my investigation along these lines because they are needed to show that the process described would be too costly with power at this higher price, and because it is possible that, in the future, power may be available at a lower price, which would then permit of operations being undertaken.

In view of the very high price asked for electric power I have paid special attention to a new process for producing electric furnace iron which offers possibilities of a decided economy as compared with standard methods. I have presented the available information and made estimates of the cost at which iron may possibly be smelted by these means.

The whole investigation is necessarily very extensive, and it is a matter of some difficulty even to present the results in a clear and simple manner; especially as each conclusion arrived at, is dependent on a number of factors which cannot be stated in a few words, and many of which are liable to change. The information obtained is set forth and discussed in detail in a number of appendices; while the conclusions arrived at are presented as concisely as possible in the following report:

Electric Smelting of Iron Ore.

This has passed the experimental stage and is in operation commercially on a large scale in Sweden and elsewhere. The product of this operation is a special quality of high grade iron which commands a higher price than ordinary blast furnace iron, and the cost of production is in general too high to allow of competition at equal prices with the blast furnace product. Carbonaceous material is needed, even in electric furnaces, for reducing the iron ore to metal, and for this purpose charcoal is preferable and is generally used. The electric furnace that has been adopted for the commercial smelting of pig iron is that of Messrs. Electro-Metals Ltd., of Sweden, which may be regarded as the standard. The pig iron normally produced from this furnace, although unusually pure and commanding a high price, is a white, or low silicon iron, unsuitable for use in the iron foundry. The officials of the Swedish Company consider that a foundry iron can be made by these furnaces, though at a somewhat higher cost, but I have no evidence that this has been accomplished in regular commercial practice, and the Noble Electric Steel Company which smelted iron ores electrically for several years, at Heroult in California, was obliged to adopt a different type of furnace for the production of foundry iron. I consider, however, that the Electro-Metals furnace could be used for this purpose because any low silicon iron could be made suitable for foundry use by additions of ferro silicon; but considerations which will determine the best type of furnace for use in British Columbia are given later in the report.

Facilities for Electric Smelting in British Columbia.

The essential conditions for the electric smelting of iron ores on a commercial scale are,—a supply of high grade ores at a reasonable price, an ample supply of cheap electric power, a supply of charcoal or other fuel at a moderate price, a supply of labour at a moderate price, a suitable location for the smelting plant and a sufficient market for the resulting iron at a rather high price. The situation in British Columbia may be considered under these separate heads as follows:—

Iron Ores.—The information furnished to me by your officials shows that the iron ore deposits of the Province have not been opened up to any extent, but that it is safe to assume that adequate supplies of ore of reasonable richness and purity can be obtained at easily accessible points. These ores are chiefly magnetites and, on this acount, are undesirable for use in the blast furnace except in admixture with other ores; magnetites are, however, quite suitable for treatment in the electric furnace. It appears that the ores are not of very high grade, but that a supply may be expected to contain from 50 to 55 per cent of iron. The ores are practically free from phosphorus and titanium and the proportion of sulphur can probably be kept as low as 0.1 per cent. The ores under consideration are also practically free from copper. Your officials estimate that a supply of 50,000 tons per annum of ore of this grade can be delivered at a suitable smelter site, at a

cost, under present conditions, of about $4.00 per net ton, which would be made up as follows:

Mining	$1.50 to $2.00
Loading or tramming	0.15 to 0.25
Freight (by water)	1.00 to 1.50
Unloading	25 cents.
*Royalty to owner	50 cents
Total cost at smelter	$3.96 to $4.10

From the information at my disposal I feel satisfied that these ores can be smelted electrically for the production of a high grade pig iron. For the production of one long ton† of pig iron about 2.0 net tons of 55 per cent ore would be needed, so that the ore would cost $8.00 per long ton of pig iron. In view of the somewhat low grade of the ore, the cost of smelting, per ton of product, will be rather higher than is usual with the Swedish ores; but this may perhaps be remedied by the use of magnetic concentration.

Electric Power.—British Columbia is well provided with water powers, and many of these can be developed cheaply for the use of electric smelting and similar industries. Competent engineers have assured me that some of these powers in accessible locations can be developed at such a cost as to yield a continuous electrical horse power for smelting at a cost of $10.00 per annum. This figure is not much higher than obtains in Sweden, and if a dependable supply of power can be secured at this rate it seems almost certain that an electric iron smelting industry can be undertaken profitably. The consumption of power, under conditions obtaining in British Columbia, would be between 0.4 and 0.5 of a horse-power-year per ton of iron produced; so that the cost for power should be between $4.00 and $5.00 per long ton of pig iron. Some 8,000 or 9,000 horse-power would be needed for a daily production of 50 tons of pig iron.

In view of the desirability of producing pig iron at the earliest possible time, and of the difficulty and expense attending the development of water powers under present conditions, it is highly desirable, if not imperative, that an electric smelting industry shall be supplied, in the first place, from powers that are already developed. The British Columbia Electric Railway Company has surplus power which might be employed for this purpose, and I gathered from the officials of this company that they could possibly supply such power at $15.00 per horse-power-year, a charge which appeared to me to be the highest that the industry could support. Under these conditions the cost for power per ton of pig would be between $6.00 and $7.50.

† **Long and Short Tons.**—Pig iron is sold by the long or gross ton of 2240 lbs. not only in England and Canada, but in the United States, and I have conformed with this custom in my report. The supplies needed for smelting, such as iron ore, charcoal, coal and coke are sold in British Columbia by the short or net ton of 2000 lbs., and the use of this dual system has necessarily complicated the calculations in this report. The situation is further complicated because, in Government reports, pig iron is estimated by the short ton, and in regard to pig iron quotations in British Columbia, it is sometimes difficult to say which ton is intended. In Sweden a more consistent system is followed, as the pig iron and all the necessary supplies are measured by the metric ton of 1000 kilograms or 2204 lbs. This ton, which may be assumed in all statements of the Electro-Metals Company of that country, can be taken, without serious error, to be the same as the long ton.

*Using a Royalty in this estimate removes the need of considering the purchase of an iron mine.

Since returning to Montreal I have received a letter, dated September 12th, from the General Manager of this Company, informing me that conditions have changed since my visit and that they would now have to charge higher rates. They would be willing to make short term contracts for from 2,000 K.W. to 10,000 K.W. of electric power in Vancouver district, for restricted service during the peak load periods, at a rate of 0.5 cent per K.W. hour. This charge would amount in effect to at least $27.80 per horse-power-year, and would represent a charge of from $11.00 to $14.00 per ton of iron. They would also offer 2,000 K.W. of power on Vancouver Island at $15.00 per horse-power-year for a short term and subject to peak load restriction. The proposed charge in Vancouver is, I believe, altogether too high to allow of the commercial production of pig iron by present methods, except perhaps on a small scale as a temporary operation to take advantage of the present high prices of pig iron. The supply on Vancouver Island, besides its uncertainty, is too small to permit of profitable operation.

Charcoal and Coke for Reduction.—For the electric smelting of iron ores a supply of carbonaceous material is needed for reducing the iron ore to metal. For this purpose charcoal is generally used, although coke is employed to some extent. Charcoal is preferable to coke on account of its greater purity, as a higher grade of pig iron can be obtained by its use. The use of charcoal is more satisfactory also from an operating point of view, and the consumption of power is greater when coke is employed; a proportion of coke can, however, be used without difficulty in admixture with charcoal. The consumption of charcoal varies with the grade of iron required, and the type of furnace employed, from about 0.4 to 0.5 net tons of charcoal per long ton of pig iron, so that 20 or 25 tons of charcoal would be needed daily, for an output of 50 tons of pig.

In the coast districts of British Columbia there is an abundant supply of timber from which charcoal can be made suitable for use in electric smelting. At present there is no considerable charcoal industry and the small quantities now obtainable cost as much as $30.00 per ton, a figure which would be prohibitive for the electric smelting of iron ores. In view, however, of the large amount of waste wood produced at some of the large saw mills, it appears reasonable to suppose that a well designed charring plant can be erected, that would utilize this waste material, and deliver charcoal to the smelter at a cost of from $6.00 to $8.00 per net ton; estimated on the folowing basis:

2½ cords of Douglas Fir mill waste	$2.50
Cost of charring, less returns for by-products	2.50
Carriage of charcoal to smelter	1.00
	$6.00

The charge per ton of iron would thus be between $2.40 and $4.00.

With regard to the method to be employed it may be stated briefly that the Douglas Fir, which would probably constitute the staple supply for charcoal making, does not furnish by-products of suitable quality and quantity to warrant the use of elaborate methods for their recovery. Charcoal should therefore be made in large kilns, or in some appliance which might be devised to char the wood waste with the minimum amount of hand labour; in either case a partial recovery of by-products could be made at a moderate expense.

It does not appear that coke can be produced from

British Columbia coals at a price that would be as low as that of charcoal; and unless the coke was decidedly the cheaper per ton it would be more economical to use charcoal. Coke braize, however, can probably be obtained for a very nominal charge, and can be used in admixture with charcoal in cases where extreme purity of the pig iron is not desired.

Labour.—The Department of Labour has furnished me with a statement of the supply, nature and cost of labour in British Columbia, from which it appears that labourers are fairly plentiful and receive nearly $4.00 a day, and that most skilled men are scarce at about $6.00 a day. The cost of labour, per ton of product, will depend very largely on the size and output of the plant and the nature of its equipment; but it appears that in a fully equipped plant making about 50 tons of pig iron, daily, besides steel and ferro-alloys, the cost of labour might be from $4.00 to $5.00 per ton of iron; although, in the initial stages, the labour cost would certainly be higher, perhaps in the order of $7.00 per ton of iron. The manner in which these figures are arrived at is stated in the appendices.

Location for Smelting Plant.—A plant for the electric smelting of iron ores should be conveniently situated with respect to the supplies of ore, charcoal and other requirements; it should also permit of cheap delivery of the iron and other products to market. The plant must be placed as close as is convenient to the source of electric power, so as to lessen the cost of transmission. When a satisfactory supply of power has been secured it will doubtless be possible to obtain a smelter site within a reasonable distance of the power station and located on tidewater so as to provide for cheap delivery of supplies and products. A plant located near a centre of population, such as Vancouver, would have advantages with respect to labour and general supplies and nearness to markets, but the provision of an adequate and cheap supply of electric power, iron ore and charcoal should be the determining consideration.

Market for Pig Iron.—For the purposes of this report I have limited my investigation to the market in British Columbia itself, though a moderate export market may be developed later. The present consumption of pig iron is only about 10 tons daily, but it appears that the consumption has been seriously limited by the extremely high prices now ruling, and that if a supply of iron becomes available at a moderate price, a consumption of 20 or 30 tons may be expected. This amount is too small to permit of economical operation, and I would therefore recommend, if a suitable supply of electric power can be obtained, that a plant be constructed to produce say 25 tons daily of foundry iron for sale and a further 25 or 30 tons of low silicon iron for conversion into steel. I have not investigated the market for steel in any detail, but apparently a sufficient market for this product could be found.

The prices of foundry iron in Vancouver have varied recently from about $60 to $80 per long ton. Before the war the price was around $25. It seems unlikely that the price for good foundry iron will fall much below $35 a long ton during the next few years. In most localities, electric smelting depends for its commercial possibility on obtaining for its product a higher price than that of ordinary foundry iron. I find that, at present, there is scarcely any demand in British Columbia for such special grades of iron, but there can be no doubt that they will be needed in the future, as the iron and steel industry develops.

Foreign Competition.—The market prices already mentioned as obtaining in British Columbia are based on the present sources of supply from eastern points in Canada and the United States. It is possible that an iron blast furnace plant may be established on the Pacific coast of the United States, and the effect of this on the market in British Columbia must be considered. It appears that pig iron could be made, in such a plant at a cost of about $25 per long ton, under present conditions. The duty on pig iron entering Canada from the States is $2.80 per long ton plus 7½ per cent ad valorem, which, at a sale price of $30.00 per ton, would amount to $2.25 per long ton, or a total charge of about $5.00. This duty, together with the freight charge and the Canadian bounty, would place the electric furnace iron, if made with $15.00 power, on an equality with imported blast furnace iron. This would not hold in the case of iron imported for war work, as this is duty free, and after the war the duty of 7½ per cent ad valorem will no doubt be removed. In this connection it may be added that a large iron and steel plant can scarcely be built until some years after the war, so that an electric furnace plant, if constructed promptly, would command the market for a number of years. Ultimately, blast furnace iron may be expected to take a part at least of the market for common grades of iron, but the electric furnace should always be able to command a small market for its higher grade of iron.

Arrangement with the Dominion Government. — A deputation from British Columbia went to Ottawa, early in the present year, seeking for aid to develop an iron industry in British Columbia. In answer to their request, the Dominion Government undertook for a period of some years to purchase, if necessary, at market prices, the whole output of a plant making pig iron in British Columbia. This agreement will no doubt apply equally to electric furnace iron, but it does not appear to me that it is likely to help matters materially, for the following reasons: I. The offer is obviously of no use if the price referred to is that obtaining in Eastern Canada, as iron could not be made at that price. 2. If the price intended is the local price in British Columbia we are met with the difficulty that the Government's ability to carry out the undertaking would be limited to the local demand for iron, as it would be impossible for it to buy expensive iron in British Columbia and ship it to lower-priced markets elsewhere. We are thus limited to the natural market for iron and steel in British Columbia and to possibilities for exportation on a small scale.

Bounties and Taxes.—The Provincial Government has offered a bounty of $3.00 per net ton on pig iron made in British Columbia, from local ores, and on the other hand imposes a tax of 37½ cents per net ton of iron ore mined. The combined effect of these measures will be a payment of about $2.60 per gross ton of pig iron; a source of income which will be of some importance, and may sometimes make the difference between operating at a loss and at a profit.

Type of Furnace to Use for Electric Iron Smelting.

A point of considerable importance to this investigation is the determination of the most suitable type of electric furnace. This is important not only for the guidance of those who may undertake the establishment of an electric smelting plant in British Columbia, but also in order to arrive at reasonably accurate figures for the cost of the plant and the cost per ton of the

product. In outline the situation is substantially as follows:—

1. In Sweden the firm of Electro-Metals (of Ludvika and London) has developed a type of electric smelting furnace which has proved very satisfactory for the production of low silicon pig iron from the Swedish ores. There are now 17 of these furnaces at work in Sweden, ranging in size from 2000 K.W. to 5,000 K.W., and a few in Norway, Switzerland and Japan. This is, as far as I am aware, the only type of electric furnace that has ever attained commercial success in the production of pig iron from iron ores.

The furnace is circular in plan and is provided with a tall-stack i nwhich the ore is preheated and partially reduced before it enters the smelting chamber. This reduction of the ore is aided by a mechanical circulation of the furnace gases, which are withdrawn from the top of the shaft, freed from dust, and then blown through tuyeres into the smelting chamber above the ore. The gases become heated at this point and passing up the shaft they heat and reduce the ore. The circulation of the gases also serves to cool and protect the arch of the smelting chamber, but on the other hand it increases, slightly, the consumption of the electrodes.

On account of these special features, the Electro-Metals furnace uses somewhat less charcoal than a simpler type of furnace, a difference of say 1-10 ton per ton of pig iron, and it is believed to use less power. The saving in charcoal is probably more than offset by the need of a better quality of charcoal, which is rendered necessary by the use of a tall shaft. It must be noted, however, that the usual product of the Electro-Metals furnace is a white pig iron suitable for chilled castings or for steel making, while the need in British Columbia would be largely for a foundry iron. There does not appear to be any evidence that the Swedish furnaces have been used regularly for the production of foundry iron, and there seems to be some doubt regarding their suitability for this purpose.

2. An independent development of electric iron smelting took place at Heroult, Shasta County, California, where a deposit of very pure magnetite has been smelted electrically, by the Noble Electric Steel Company, for the production of foundry iron. Operations were started in 1907 by the late Dr. Heroult, who built a simple rectangular furnace having an arched roof, and ore chutes in which the charge could be preheated. As this furnace did not prove satisfactory, a shaft furnace of the Swedish type was tried. This was also unsatisfactory and the management reverted to the rectangular type with arched roof and with charging chutes, in which, however, the ore was not pre-heated. It was claimed at the time (1913) that success had been obtained with this furnace, but nothing further was published about it, and I find that its use was discontinued about four years ago. The plant is at present employed solely for the production of ferro alloys, because the price now charged for electric power, the cost of charcoal, and the cost of transportation are all so high as to render impossible the commercial production of pig iron. I am of the opinion that we cannot accept the work at Heroult as an argument for or against the type of furnace that was used there.

3. Another furnace of the closed rectangular type was devised by Helfenstein for the production of calcium carbide and ferro silicon. A Helfenstein furnace for smelting iron ores was being tried at Domnarfvet in Sweden at the time of my visit in 1914. At that time the management was unwilling to give any information about its operation. An account published a year or two later stated that this furnace was working satisfactorily, but Messrs. Electro-Metals now inform me that "the furnace was found quite useless and has been pulled out."

4. For the production of ferro-silicon, ferro-manganese and calcium carbide, a simple rectangular open-topped furnace has been developed, and is in use at many places. In this furnace, no attempt is made to preheat the ore, and the gases, produced in the furnace, escape and are lost; besides creating a nuisance by burning above the furnace. On the other hand, the furnace is easy to build, simple to operate, and is probably not far inferior to the Swedish furnace in commercial efficiency. I am not aware that this furnace has been used commercially for making pig iron, but there can be no doubt that pig iron of any desired variety could be made in it. The Beckman and Linden Engineering Corporation of San Francisco, who are using it for ferro-manganese, consider that it would be preferable to the Swedish furnace for making pig iron, and that it would be little if any inferior in point of economy.

Conclusions.

(1) If a permanent smelting plant were being erected, the Swedish type of furnace would be selected, because it is more economical than any other at present in use, and is the only one that has been employed commercially.

(2) If a temporary plant is contemplated, it may be better to instal the open pit furnace, on account of its smaller first cost and the ease with which it can be converted to other uses.

(3) Information should be obtained with regard to the iron ore reduction process of Trood and Darrah as this may prove superior to any direct smelting process. If this process is likely to be available, it will be best in the meantime to use a simple pit furnace, rather than to instal the more elaborate Swedish furnace.

Further particulars in regard to the two types of furnaces will be found in appendix VIII.

Cost of Production.

In order to arrive at an approximate estimate of the cost of smelting iron ores, it is necessary, in the first place, to decide upon the scale of operation. In view of the local market and other considerations, which I discuss elsewhere, I suggest the following equipment as being suitable for an electric smelting plant in British Columbia, providing that the usual electric smelting methods are adopted.

Outline of Plant.—One electric smelting furnace of 3,000 K.W. making daily about 25 tons of foundry iron for sale.

One electric smelting furnace of 3,000 K.W., making daily about 30 tons of low silicon for conversion into steel.

Three electric furnaces of 300 K.W. each, making together about 3 tons of ferro alloys.

Two electric steel furnaces of 1,500 K.W. each, making together about 50 tons of steel.

Steel foundry and rolling mill using 50 tons of steel daily.

Cost of Plant.—The design and cost of such a plant is discussed in the appendix. As, however, it would be very difficult to use so complicated a plant as a basis for estimating the cost of making pig iron, I shall consider, for this purpose, a plant of about equal size, devoted entirely to the production of foundry iron. In so doing I am making the assumption, which will not be

very far wrong, that the cost of making pig iron in the simple plant will afford a fairly correct idea of the cost of making it in the complex plant, outlined above, which would be suited to the local requirements.

The simple plant, assumed for purposes of calculation only, would consist of three electric smelting furnaces of 3,000 K.W. each, producing altogether about 80 tons of pig iron daily.

The cost of such a plant, and of smelting iron in it will depend on the type of furnace employed. The most economical furnace, as far as my information goes, is that of the Electro-Metals Company, and I give in the first place an estimate based upon its use.

An electric iron-smelting plant of this type, containing three 3,000 K.W. furnaces, would cost from $350,000 to $400,000 to erect in British Columbia (details are given in the appendix) and should have a production of 27,000 long tons of foundry iron per annum.

Cost of Electric Smelting.—The cost of making a long ton of foundry pig iron, in such a plant, would be estimated as follows, assuming that power can be obtained at $15.00 per horse-power-year:

Smelting in Swedish Furnace With $15.00 *Power.*

Iron ore, 2.0 net tons at $4.00	$8.00
Electric Power, 0.45 h.p. year at $15.00	6.75
Charcoal, 0.4 net tons at $8.00	3.20
Electrodes, 15 lbs. at 8 cents	1.20
Repairs and maintenance	1.00
Labour	4.50
Management	2.00
Interest, 6 per cent on total capital, and depreciation, 10 per cent on cost of plant....	2.60
Royalty to Electro-Metals Company	0.50
	$29.75

If power could be obtained at $10.00 per horse-power-year the charge for this item would be $4.50 and the total cost of a ton of pig iron would be $27.50.

If power were to cost 0.5 cent per K.W. hr. the charge for power would be about $12.50 and the total cost of a ton of pig iron would be $35.50.

In regard to these figures it should be stated that the Electro-Metals furnace is a somewhat elaborate appliance, and that a plant with furnaces of this type should not be constructed unless a permanent supply of cheap power can be assured. This is not so much because of the cost of construction, which may not be much more, per ton of yearly product, than that of a plant with the simplest type of furnace, but because the furnace, and the building containing it, are entirely specialized, and would be of no use for any other purpose. If, for any reason, it should be decided to erect a plant with an expensive or a temporary source of power, it would be desirable to arrange for a plant of the type in use for making ferro alloys, as the furnace, and plant generally, could readily be converted to other purposes, if at any time it became inadvisable to make pig iron. With this simpler type of furnace the cost of making pig iron would probably be about $5 higher, per ton, than the above estimates; thus the cost of a ton of pig iron would be $35 per ton, if power costs $15 per horse-power-year, and would be more than $40 per ton with power costing 0.5 cents per kilowatt hour.

The following table will give an idea of the distribution of costs under these conditions:

Smelting in Swedish Furnace With 0.5 Cent Power.

Iron ore, 2 tons at $4.00 per ton	$8.00
Electric power, 0.5 h.p. year at $27.80	13.90
Charcoal, 0.5 ton at $6.00 per ton	3.00
Electrodes, 20 lbs. at 8c per lb.	1.60
Repairs and maintenance	1.00
Labour	6.00
Plant and general office expenses	4.00
Interest and depreciation	3.00
	$40.50

The prices obtained for pig iron in British Columbia during the last year or two have been considerably higher than this, but it does not seem safe to count on a price of more than about $35 a ton during the next few years, so that making iron under these conditions would appear to be out of the question.

Magnetic Concentration of Iron Ores.

As the cost of smelting iron ore is greater, per ton of the product, with poor ores than with rich ores, and as the ores in British Columbia are only expected to contain 50 per cent to 55 per cent of iron, with about 23 per cent to 30 per cent of gangue, it is worth considering whether it will pay to concentrate the ore preparatory to smelting.

Until adequate samples of the ores have been obtained, analysed and submitted to magnetic concentration, it is impossible to discuss this subject except in general terms.

1. If the ore is of such a nature that after breaking down to a size of about one inch the ore can be concentrated magnetically so as to reject a large part of the gangue, it will usually pay to do this before smelting.

2. If the ore is so finely grained that it is necessary to crush it to a sand before magnetic dressing, there will be involved the cost of the fine crushing and also the cost of briquetting or sintering the concentrates to make them suitable for smelting.

3. In the case of an ore that does not contain over 50 per cent of iron, if the ore lends itself readily to magnetic concentration so that very fine grinding is unnecessary and a clean separation can be obtained, the saving in the cost of smelting will probably pay for the cost of crushing, magnetic dressing, and sintering with sawdust on a Dwight-Lloyd machine. The ore will incidentally be improved by the removal of phosphorus and sulphur, and will be left in a condition more favourable for smelting.

4. If preliminary reduction of the ore is employed, the ore will have to be crushed to a coarse powder, and magnetic concentration will then form an essential step in the process; being applied either before or after the reducing operation.

Auxiliary Industries.

On account of the limited market for pig iron in British Columbia, it will be impossible to conduct at a profit a plant producing nothing but pig iron. By including in the plant the production of steel and ferro alloys, the plant will be more likely to pay.

Steel.—In view of the small size of the industry, it will be out of the question to attempt to roll large plates for shipbuilding or large structural sections or rails, but small sections and bars of structural steel can be rolled, besides bars of cast steel for drills and similar purposes. Steel will also be needed for the production of steel castings.

The steel can be melted in an open-hearth or an electric steel furnace, using, as stock, steel scrap, and white pig iron from the electric smelting furnace. If it is desired to charge the pig iron in the molten state, so as to save the cost of remelting, a "mixer" will be needed, to keep the iron molten until it is needed. As the

iron ore is low in phosphorus the iron will be of "Bessemer" quality and an acid lined furnace will be satisfactory for steel making. A small rolling mill and a steel foundry will form necessary adjuncts of the plant. Further particulars are given in Appendix XIII.

Ferro Alloys. The production of these alloys would form a simple and profitable part of the work of such a plant. The alloys that would probably be made are Ferro Manganese, Ferro Chrome and Ferro Silicon. The essential ingredients of these are manganese ore, chrome ore, quartz, scrap iron or iron ore and charcoal or coke. All these are available, and these alloys can be made in the small 300 K.W. single phase furnaces mentioned in the design. Information with regard to the supply of manganese and chrome ores, and the methods and costs of making ferro alloys, will be found in Appendix XIII.

A New Method of Producing Electric Furnace Iron.

It has been pointed out that an electric smelting industry must depend, for the present, on electric power furnished by the power companies of British Columbia. It has also been stated that the company best able to supply power has asked so high a price that the commercial production of pig iron by electric smelting seems to be impossible. Under these conditions it would appear that nothing can be done except to wait for cheaper power or to make a little pig iron as a part of some more remunerative operation.

There is, however, in view at the present time, the possibility of an entirely different method, which may possibly enable iron and steel of electric furnace quality to be produced at a decidedly lower cost than that of direct smelting in the electric furnace. According to this method the iron ore would be crushed to a coarse powder, the gangue removed by magnetic concentration, and the nearly pure iron mineral exposed to reducing gases or carbonaceous reducing materials, at moderate furnace temperatures, until the grains of iron ore are converted into grains of metallic iron. This grain metal can then be melted in electric furnaces, with suitable additions, for the production of both pig iron and steel. The electric power needed for the final melting of the metallic powder would be less than one-third of that required for smelting the iron ore by existing methods, and it seems quite possible that the preliminary reduction of the ore, using waste wood or other cheap fuel, can be effected so cheaply that there will be a substantial saving on the whole process. It will also be noticed that one operation, the conversion of pig iron into steel, will be avoided by the new process.

This new process was referred to in my letter of May 26th to Mr. W. Fleet Robertson. I had at that time applied to the Advisory Research Council for funds to assist me in investigating the reduction of iron ores, but I have not as yet been able to begin experimentation.

During my visit to California I heard of the work of Dr. Trood and Mr. Darrah along similar lines, and I met these gentlemen at Heroult, where I saw, in operation, a small plant for the reduction of magnetite ore to metallic iron. I am not at liberty to give full particulars of their process, but can state that it consists substantially in heating the coarsely powdered magnetite with charcoal or other carbonaceous reducing material to a temperature of 800 deg. C. for about three hours. In the small plant the heat was supplied electrically, which was more convenient and also permitted of more accurate measurement, but on the large scale, it is probable that fuel heat would be employed. I have received, from Mr. Darrah, data in regard to the operation, and I have modified these to suit conditions in British Columbia. It will be seen that, even if electrical heat is used for reduction and melting, there should be a decided economy as compared with the direct smelting process.

Cost of One Ton of Reduced Iron

(In a plant making 100 tons daily).

Ore, 2 tons at $4.00	$8.00
Charcoal, 1-3 ton at $6.00	2.00
Power for heating, 1380 K.W. hrs. at ½ cent.	6.90
Crushing materials, at 50c per ton	1.00
Handling materials, at 50c per ton	1.00
Labour and supervision	.85
Interest and depreciation on an investment of $20,000	.25
	$20.00

The operation of converting this metallic powder into foundry pig iron would have to be worked out experimentally, but I believe, with electric power costing ½ cent per unit, and with other supplies at the rates assumed in this report, that the cost of this operation would be about $10.00 per ton of pig iron. The final cost of a ton of iron would therefore be $30.00, even using high priced power; and if this figure can be substantiated, it becomes clear that an electric iron industry can be started in British Columbia under present conditions. I am of the opinion, also, that the electrical power, used for reducing the ore, can be replaced by 1-3 ton, or at the most ½ ton, of coal or similar fuel, or even by waste wood. If this can be done the charge for heat may be reduced to $2.00, and the cost per ton of metallic powder to $15.00, so that a ton of foundry pig iron, produced by this process, should cost only $25.00.

If it is found possible, in practice, even to approach these estimates it will be clear that an electric iron industry can be undertaken immediately in British Columbia, and in some other parts of Canada, and that the plants that are now employed for the electric smelting of iron ores may have to be remodelled. I must repeat however, that although the results indicated appear to me to be very probable. I have not as yet enough information to speak with entire certainty, and further experimental work must be undertaken before it would be safe to proceed to the erection of a plant.

The metallic powder can be made into steel, equally easily, by melting in electric furnaces and steel ingots should be produced at a cost only a little higher than that of foundry iron—say at about $30 per ton. This would render possible a large steel industry in British Columbia.

General Considerations.

In view of the abnormal prices of products and supplies and the high cost and uncertainty of labour, it is almost impossible at the present time to arrive at any reliable conclusions with regard to the commercial side of a new industry. The high prices obtainable for iron and steel make the present time appear suitable for undertaking the production of these materials, but the increased cost of supplies and of labour largely neutralize this advantage. If it seemed probable that pre-war prices would return in the course of a year or two we

might base our calculations on this assumption, but in view of the profound change that is taking place in the position of labor, it seems unlikely that wages will ever return to their original level. One effect of this will be that the prices of supplies and products will all reach correspondingly higher figures.

If electric power could have been obtained immediately at a reasonable price it appeared reasonably safe to undertake the electric production of pig iron by standard methods, but if we are dependent on developing a water power for this purpose, the delay and the increased uncertainty in regard to costs and prices makes prediction almost impossible. In a general way, however, we may assume that in the course of a few years costs and prices will again reach some steady relationship to one another, and that this relationship will not be very different from what it was before the war.

On this assumption it would seem that, after prices have once more reached a steady level, the electric smelting of iron ores will occupy, commercially, about the same position as before the war, and by considering the condition in Sweden, which resembles Canada in many respects, we can form a fairly good judgment of the possible development of electric smelting in British Columbia.

We may therefore expect, with the present methods of electric smelting, that the industry would be successful commercially, but that it would depend ultimately on the production of special qualities of iron and steel, and would be unable to compete with the blast furnace in the production of ordinary grades of pig iron. If, however, the new process for the reduction of iron ores is found to be satisfactory it should produce a decided improvement in the commercial status of electric smelting.

Conclusions in Regard to The Electric Smelting of Iron Ores in British Columbia.

1. The three most essential requirements are: Iron ore, electric power and charcoal or similar material. In the coast districts of British Columbia there is a sufficient quantity of suitable iron ore conveniently located, water powers available for the development of electrical energy, and waste wood from saw mills for the production of charcoal.

2. Having regard to the present market for pig iron and the probable price for this material during the next few years, it appears that the iron ore, electric power and charcoal could be produced sufficiently cheaply for the commercial smelting of iron ores in electric furnaces.

3. The development of a water power is, however, a long and costly operation and one which it would be highly inadvisable to undertake at the present time. For present operations therefore we are dependent on the purchase of electric power from the power companies.

4. It appears that one of these companies has a sufficient amount of unused electric power, but it is asking a higher price for this power than the industry can bear.

5. In view of the original cost of development, it would appear that the company could afford to offer the power at a decidedly lower price, but it should be remembered that the company must keep a reserve of power for other purposes and that it cannot, at present, afford to maintain this reserve by undertaking fresh development.

6. A new process is now being investgated by means of which it may be possible to produce electric furnace pig iron commercially in spite of the high price charged for electric power.

7. In view of the small demand for pig iron in British Columbia it would be almost essential, if a smelting plant is to be established on an economic basis, that additional products shall be turned out. Steel for castings and small rolled sections, and ferro alloys such as férro manganese, ferro chrome and ferro silicon, could be made suitably in such a plant. These additional products would permit of more economical operation, would enable larger profits to be made, and would allow the plant to continue in profitable operation if at any time the price of pig iron were to fall below the cost of production.

8. In view of the present situation it appears advisable:

(*a*) To develop one or more of the best iron ore deposits and to make complete tests of the ore.

(*b*) To reserve a suitable water power for future development.

(*c*) To establish a plant for the economic production of charcoal from mill waste.

(*d*) To investigate the new process for the production of electric pig iron, and if this is found satisfactory to begin immediately to produce pig iron; purchasing power for this purpose until the water power can be developed.

SYLLABUS OF TWENTY-SIX LECTURES ON INDUSTRIAL CHEMISTRY.

The first of a series of twenty-six lectures on Industrial Chemistry was given on January 29th at the McGill University. We print below a complete syllabus of the course and wish particularly to draw our readers' attention to the same, for many of the lecturers are recognized authorities upon the subjects with which they intend to deal. The world is just emerging from a chaotic state of military ferment, and is passing into a period of the keenest commercial rivalry. The most powerful weapon for use during this strenuous experience will undoubtedly be education: education in its broadest and fullest sense. Natural resources of raw material must be opened up and exploited to the utmost; methods of treatment must be simplified and cheapened; and in every branch of commercial activity it must be fully recognized that the antiquated rule-of-thumb practice belongs to the dead past. The new conditions must be based upon scientific research, and a full acceptance and adoption of the knowledge gained from such research; for the nation that neglects to profit by such means is surely going to be out-distanced in the race for commercial supremacy. In Canada to-day there are unlimited resources, unlimited opportunities and it is the duty of every individual to utilize these to the utmost. Those responsible for the inauguration of this course of lectures are moving in accordance with the above ideas, and later on should have the satisfaction of knowing that their efforts have met with well merited appreciation.

1—Water, its industrial uses and purification, Jan. 29th—C. Hazen.

2—Apparatus and Machinery Used in the Chemical Industries, Jan. 31st—Dr. Bates.

3—Solid Fuel Coal, Ash and Peats, Powdered Coal, Feb. 5th—Dr. Porter.

4—Liquid Fuel, Srude Petroleum and Its Products, Feb. 7th—Dr. Porter.

5—Gas Fuel, Natural Producer, Feb. 12th — R. Kennedy.
6—Coal Gas, Feb. 14th—R. Kennedy.
7—Iron, Feb. 19th—W. G. Dauncey.
8—Steel, Feb. 21st—W. G. Dauncey.
9—Fats and Oils, Their Origin, Composition and Uses as Foods, etc., Feb. 26th—Dr. R. F. Ruttan.
10—Leather Tanning, Feb. 28th—T. A. Faust
11—Dyes and Dyeing, March 5th—W R. Allen.
12—Sugar (Cane and Beetroot), March 7th—C. Bardorf.
13—Pulp, March 12th—J. N. Stephenson.
14—Paper, March 14—J. N. Stephenson.
15—Sulphuric, Nitric Acid and Atmospheric, March 19th—Dr. R. McLean.
16—Explosives, March 21st—Dr. R. McLean.
17—Starch Dextrine and Glucose, March 26th—Dr. R. F. Ruttan.
18—Portland Cement, March 28th—A. C. Tagge.
19—Glass, April 2nd—Percy Cole.
20—Fertilizers and Glue, April 4th—C. Hazen.
21—Paints and Colors—G. M. Edwards.
22—Varnishes, etc.—G. M. Edwards.
23—Electro Metallurgy, April 16th—Dr. A. Stansfield.
24—Lead and Its Alloys, April 18th—H. Roast.
25—Ethyl Alcohol and Its Products, April 23rd—H. G. Schuck.
26—Distillation of Wood and Its Products, April 25th —C. Hazen.

A Few Notes on Bosh Tuyeres

By J. HOLLINGS (Brymbo).

(*Reprint of Paper presented at Meeting of English Iron and Steel Institute, September,* 1918.)

The practice of using one or more bosh tuyeres, temporarily installed, to rid a furnace of a particularly obstinate scaffold, probably dates back many years; in fact the French term "tuyeres de secours" and the German equivalent both seem to show that bosh tuyeres were originally used to meet emergencies only, nor were they, apparently, included as an integral portion of blast furnace design, anywhere, much before 1907.

A month or two after first putting them to work at Brymbo early in 1910, the blast furnace manager from a large works in Germany visited the works and showed the author drawings of his furnaces on which bosh tuyeres were illustrated. As far as the author's memory serves they were said to have been at work about a year. During a visit to the Minette districts of France and Germany in the autumn of 1910, the author found them regularly at work on several furnaces, and later visits in 1912, 1913 and 1914, showed that their continuous use was becoming more general both there and in Westphalia. Mr. Henri Verney, of the Société de l'Industrie Minérale, has kindly made enquiries for the author in France, and confirms 1907 as approximately the date when they were first continuously used in French practice. In the United States they are very rarely used even to-day.

They appear to be used mainly on furnaces making basic iron and more particularly where the slag is high in alumina, though they are installed on many large furnaces in Westphalia using a large percentage of Swedish ore.

If it were possible to obtain absolutely ideal physical, chemical and mechanical conditions in every-day blast furnace practice, bosh tuyeres would probably be neither necessary nor desirable. If a furnace were correctly designed for a given output and burden, and regularly so driven, bosh tuyeres would seldom be required, provided the size and quality of the burden, the temperature of the blast and other furnace conditions were kept as regular as is easily practicable on a modern furnace plant. Unfortunately even regular driving cannot be depended on in these days when supplies of raw materials are a source of frequent difficulty, and there is always the temptation to get more out of a furnace than it was designed for. Blast furnace practice must always, and more especially to-day, be to a great extent a series of compromises, and bosh tuyeres are one of them.

The circumstances which led to the adoption of bosh tuyeres at Brymbo were several years' bitter experience leading to the conclusion that as far as conditions there were concerned the absolutely regular descent of the burden was of greater importance than the absolute regularity of any one other factor in furnace practice.

The furnace which caused so much trouble would now be considered a mere toy, being only 48 ft. high from hearth to stock line, 8 ft. 6 ins. in hearth diameter, and 8,500 cubic feet capacity. During the last eighteen months of her campaign she averaged, however, over 700 tons of basic pig iron per week on a 38 per cent burden, which meant that the iron in the ore charged at the top was tapped as pig iron eight hours later. She had made 550 tons a week and had run months without scaffolding on many occasions, but very different conditions arose when the make was pushed to 700 and even 750 tons a week. Similarly, a furnace making 1,000 tons a week on a 37 per cent burden became an entirely different proposition when it was attempted to obtain the same weekly output from a 30 per cent burden.

Having done everything which at the time seemed feasible to ensure regularity in the size and quality of the burden and its proper distribution into the furnace, and being still troubled with scaffolds, it was decided that the easiest way to obviate them was to instal a second row of tuyeres at some distance above those in the hearth. No information was forthcoming as to the correct height above the hearth for such tuyeres, so we set about getting it for ourselves on the larger of the two furnaces mentioned above, which had then been blowing about eighteen months.

Holes were made at points "A" and "B" Fig. 1, above the mantle plate; 1 in. diameter steel pipes were

securely fastened in them, and registering pressure gauges installed on branch pipes in such a way that a rod could always be passed through the 1 in. diameter tubes to clean them preparatory to taking each reading. In practice this did not prove necessary, as the tubes were hardly ever found obstructed in any way. Moreover, holes drilled at various points in the casing above the mantle plate entirely failed on every occasion to locate any accumulations on the walls above the bosh. One small bosh tuyere was specially installed at "C," and readings of the pressure inside the furnace were taken at regular intervals by means of a very simple apparatus. A similar apparatus served to take readings at the centre of the hearth through the ordinary tuyeres. This apparatus was pushed through the bosh or hearth tuyere, the pressure read, and the apparatus withdrawn in about 30 seconds.

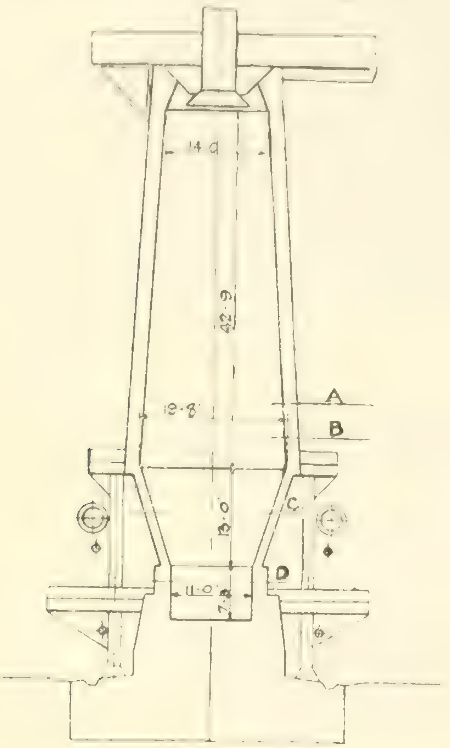


Fig. 1.—Location of the Bosh Tuyeres.

Readings were taken at points "A," "B," "C," and "D," shown on sketch No. 1, every hour to begin with, but the difficulties of keeping the bosh tuyere open with blast only going through it for a few minutes together at intervals of an hour were so great that after two days, readings at this point were given up. In normal practice, the other readings were so regular that after a week we only took readings during periods of abnormal pressures.

The furnace was being blown with a regular volume of air, irrespective of pressure, to a point. The normal blast pressure was 5 lbs. per square inch in the horse shoe main; this was allowed to rise to 9 lbs. per square inch before the volume of air was lessened. If the pressure in the horse shoe main rose above 9 lbs. the volume of air was reduced so that the pressure should under no circumstances exceed 9 lbs. Readings taken over a period of one month showed that though the pressure at "C" and "D" varied over a range of 5 lbs., the pressure at "A" and "B" never varied more than ½ lb. Moreover, this latter variation was probably due to some extent to the size of the material charged into the furnace. The supplies of ore came in on Mondays, Wednesdays and Fridays, and by Sunday morning the bunkers were getting empty and most of the material drawn from them was on the fine side. It was invariably at such times that the pressure at the points "A" and "B," shown on the diagram, was at the maximum. Clearly, therefore, the obstructions when they arose were situated between "C" and "B."

It was, therefore, decided to instal four bosh tuyeres at a height of 9 ft. 4 ins. above the centre line of the hearth tuyeres. Each bosh tuyere is surrounded with a cooler and rigged in a manner exactly similar to the ordinary hearth tuyeres

The view was taken that the use of bosh tuyeres was incorrect, theoretically, and being anxious not to overdo the quantity of blast, introduced at this point, an internal diameter of 2½ in. was selected for the bosh tuyeres. A few weeks' experience showed that this was on the small side, and the diameter was increased to 3 in., and subsequently to 4 in. The nose of the tuyere was not more than 3 in. beyond the brickwork of the bosh, which consisted of a complete rivetted steel plate sheeting, lined with 13½ in. brickwork.

No break through has ever occurred anywhere in the bosh ,nor has a hot spot above the bosh tuyeres ever been noticed, though on rare occasions hot spots occurred above the hearth tuyeres before the bosh tuyeres were installed.

The table below gives a summary of information that a number of friends in this country have been kind enough to give the author and Fig. 2 serves as a key thereto. The table shows that the number, size, and position of bosh tuyeres vary over a fairly wide range at different places.

Table.

—	A.	B.	C.	D.	E.	F.	G.	H.	Tuyeres	
									Bosh. No. Dia.	Main No. Dia.
1	20 0	12 6	8 0	5 6	9 0	6 0	6	4	5 4	8 5
1(a).	18 6	11 6	7 6	5 3	5 5	9 4	6	4	6 4	8 5
2	21 0	13 0	—	6 6	10 7	2 6	9	—	6 3	12 5-6
3.	19 10	11 0	-	5 6	6 6	12 9	9 to	·	5 { 4 to	9 6
3(a)	19 10	11 0	-	5 6	7 6	11 9	3	5	3½	9 6
4	20 0	12 6	—	7 10	10 7½	0 10½	9	6	4 6	8 5½
5.	19 0	11 0	-	5 3	9 5	3 10	6	4	5 4	8 5
5(a)	21 9	12 6	—	7 0	10 9½	3 11½	6	4	5 4	10 6
6.	19 8	11 0	7 3	5 3	9 4	5 10	6	2½	4 2½	8 5
6(a).	19 8	11 0	7 3	5 3	11 0	4 2	6	3	4 4	8 5

As to the results to be obtained by the use of bosh tuyeres, the author can here speak only from his own experience, and must rely on the members present to confirm or refute it from their own.

The figures given were obtained from a furnace with a hearth diameter of 11 ft., a bosh diameter of 19 ft. 8 in. ,a stock line diameter of 14 ft., and a bell diameter of 9 ft. The height from hearth to the bottom of bosh was 7 ft. 3 in., from the bottom of the bosh to the top bosh 13 ft., and from the top of the bosh to the stock line 32 ft. 9 in., the total capacity below the stock line being 12,600 cubic feet (see sketch No. 1). This furnace is blown with eight hearth tuyeres, those on either side

of the tap hole being 5 in. diameter, while the other six are 5½ in. diameter. The air blown when bosh tuyeres are in use varies from 14,000 to 16,000 cubic feet per minute, according to the coke available, and in normal practice the pressure is 6 lbs. per square inch.

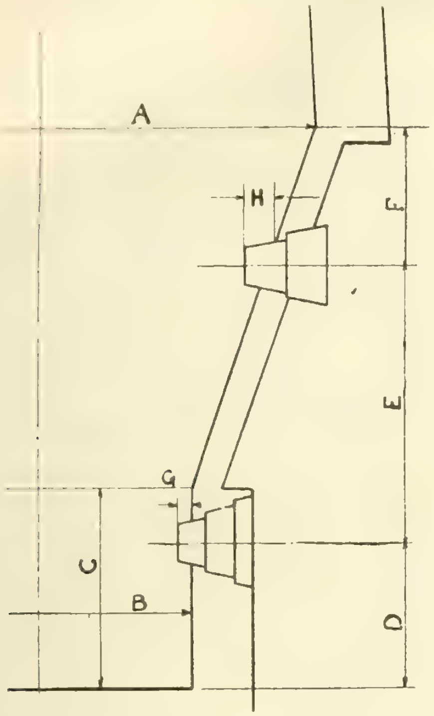


FIG. 2.—DIMENSIONS SHOWN IN ACCOMPANYING TABLE.

The furnace was blown in in the late autumn of 1908, and during the whole of 1909—running on a 35 per cent burden—made an average of 778 tons of iron per week, 74.9 per cent of which contained less than 1 per cent of Silicon, and less than 0.1 per cent of Sulphur. The coke consumption over the whole period averaged 22.4 cwts. per ton of pig iron. Throughout this period the furnace was working without bosh tuyeres, and troubles with scaffolds were not infrequent, particularly when any attempt was made to increase the driving. Bosh tuyeres were inserted early in 1910. During the coal strike in 1912, the stock line was repaired, and over the whole of 1913 the furnace was running with four bosh tuyeres, at least three of which were continually open. The average make per week on a 37 per cent burden was 1,016 tons; 89 per cent of which contained less than 1 per cent of Silicon and less than 1 per cent of Sulphur. The coke consumption during this period was 23.1 cwts. per ton of pig iron. The two years, 1909 and 1913, are given, because in each case the furnace lining had only been in use about a year, and, as far as the condition of the furnace itself is concerned, the comparison therefore is a sound one.

After allowing for the fact that the burden in 1913 was 2 per cent higher than in 1909, the increased output due to the use of bosh tuyeres may be estimated at approximately 20 per cent.

During the year 1916, the furnace was working on a very much leaner burden; the average throughout the year was only 30 per cent. With this, the average make was 872 tosn a week, of which 85 per cent contained less than 1 per cent of Silicon, and less than 0.1 per cent of Sulphur. The coke consumption on this burden was 25.9 cwts. Bosh tuyeres were used throughout the year.

As a result of his experience, the author would have no hesitation in providing for the inclusion of bosh tuyeres in any new furnace in which it was intended to make basic iron; they could then be rapidly installed if occasion arose. Against this, it cannot be denied that the coke consumption per ton of not be denied that the coke consumption per ton of pig iron has been increased to a slight extent. By keeping the proportion of air blown through the bosh tuyeres to the lowest practicable minimum, the increase in coke consumption has not exceeded ½ cwt. per ton of pig iron, which is a small price to pay for the other advantages derived. Part of this increase may be due to the increased speed of driving. On a given burden there is a maximum economical speed of driving for every furnace; any lower rate of driving results in increased fuel consumption to meet the greater radiation losses, and on the other hand any higher rate of driving involves incomplete preparation of the burden in the upper part of the furnace, and greatly increased work in the melting zone and the hearth, with a correspondingly increased fuel consumption.

When the furnace referred to is making 1,000 tons a week, her output of pig iron per twenty-four hours is one ton for every 87 cubic feet of furnace capacity, whereas for the most economical results from the burden we are using it should not exceed one ton of pig iron per twenty-four hours for every 100 cubic feet of furnace capacity.

All the tuyeres at Brymbo—both hearth and bosh—are installed on a system which was patened some years ago by Mr. W. J. Foster. The patent has, the author believes, run out, but his experience of the system has been so entirely satisfactory that he ventures to allude to it here.

The water inlet pipes to the tuyeres are coupled to a ring water main round the furnace in the usual way, but, in addition, the discharge pipes are all coupled to a similar ring main placed below the tapping platform. This main is coupled to a syphon or pump, so that it is always under partial vacuum. In this way, though the water passing through the tuyeres may be greater in volume than in the usual system, the pressure in the tuyeres themselves is zero or below, and consequently it is possible to run with quite a large hole in a tuyere and yet admit no appreciable quantity of water into the furnace hearth. Not infrequently a tuyere has been taken out which on examination proved to have a hole 4 in. long, varying in width from 1-16 in. to ½ in., and yet the failure of the tuyeres had not involved any change in the grade of iron we were making.

Many furnaces are constructed with the tapping platform only very slightly above pig bed leved; in these instances, it is not such an easy matter to couple the hearth tuyeres on the vacuum system, but bosh tuyeres are always placed at such a height that it is easy to adopt the arrangement in their case, and from the author's experience he would have no hestitation in advising everyone to do so, as leaks from bosh tuyeres are apt to be a good deal more troublesome than those at the hearth tuyeres.

The author's thanks are due to M. Henri Verney, St. Etienne, France; Mr. W. E. Snyder, The American Steel and Wire Company, Pittsburgh; Colonel W. Hawdon; and Messrs. F. W. Cooper, James Henderson, A. K. Reese, and P. Williams, for information promptly and most obligingly supplied and to Mr W. H. Hallam, the author's blast furnace foreman, for much valuable assistance in obtaining the data from which the position and size of the bosh tuyeres were decided.

The Utilization of Waste Heat From Open-Hearth Furnaces for the Generation of Steam

By THOMAS B. MACKENZIE, M.I. Mech. E.
(Motherwell).

(Reprint of Paper presented at Meeting of English Iron and Steel Institute, September, 1918.)

Note: In the following article it has been necessary to substitute in formulas and text the italic cypher (*0*) for the Greek letter "theta." No italic cypher appears otherwise in the article.—Publisher.

About twenty years ago the firm with which the author is connected was engaged in laying down a new smelting-shop with acid-lined open-hearth furnaces of a nominal capacity of 60 tons, and it was decided to put boilers between them and the chimneys, with the intention of generating enough steam to blow the gas-producers.

The boilers selected were of the Cornish type, 30 feet long by 7 feet diameter, with a single internal flue 42 inches in diameter. The waste gas from the furnace was divided into three streams, each of which travelled once along the length of the boiler, reuniting again at the chimney end.

These boilers were duly erected and tried, but owing to the cooling effect on the gases the draft of the furnaces was reduced to such an extent that their operation was slowed down sufficiently to compel this attempt to recover the waste heat to be abandoned. The boilers were accordingly removed, re-erected in ordinary settings, and fired by hand in the usual way.

Although this method of utilising the waste heat from the furnaces had proved abortive the author was not convinced that the problem could not be solved, and after giving the subject some thought it occurred to him that the placing of an induced draft fan beyond the boiler would be a solution.

In order to put his ideas on record he prepared a paper on the subject, which was read before the Institution of Engineers and Shipbuilders in Scotland on March 21, 1911, the title of the paper being "On Means for Economising Fuel and Utilising Waste Heat in Malleable Iron and Steel Works."

As a direct result of the paper the author was given permission to have an experimental boiler, economiser, and fan, on the lines he had advocated, attached to one of the smaller furnaces in the works to test the predictions made.

The furnace selected for the experiment was an acid-lined open-hearth furnace of ordinary construction and of 30 tons nominal capacity. The boiler selected was of the Babcock and Wilcox water-tube type, having a heating surface of 1619 square feet. In series with the boiler was placed a Green's economiser, having a heating surface of 720 square feet. The fan adopted was of the Keith and Blackman type, having an impeller 20 inches diameter driven by a variable speed direct current motor of 20 brake-horse-power. As originally erected, two openings were made in the steel chimney attached to the furnace—a lower one to admit the waste gases to the boiler, and a higher one for their return after passing over the heating surfaces of boiler and economiser, a cast-iron damper of the butterfly type being fitted in the chimney between the openings. This arrangement did not work satisfactorily, as the damper could not be kept tight. A plate damper was then fitted at the top of the chimney, the upper opening closed, and the fan arranged to discharge direct into the air. After some other minor troubles had been overcome the installation was got to work satisfactorily, and a test was made extending over a period of 111¼ hours, in order that a fair average from all conditions of the furnace would be arrived at. See Diagram 1, Plate I.

The mean values of the observed data are as follows:

Temperature of "products" entering boiler	504° C.
Temperature of "products" leaving boiler and entering economiser	254° C.
Temperature of "products" leaving economiser and entering fan	169° C
Temperature of cold feed entering economiser	11.6° C.
Temperature of hot feed leaving economiser and entering boiler	117.8° C
Steam pressure per square inch (gauge)	86.5 lbs.
Dryness factor (assumed)	0.95
Weight of water evaporated per hour, actual	2440 lbs.
Weight of water evaporated per hour, "from and at"	2800 lbs.
Weight of water evaporated "from and at" per square foot of boiler heating surface	1.73 lbs.
Natural draft of chimney with boiler, etc., dampered off	0.6 in. W.G.
Draft at base of chimney with boiler, etc., on and fan running	0.8 in. W.G.
Probable volume of "products" at s.t.p. passing through boiler, economiser, and fan per hour	380,000 ft.^{3}

From these data the following heat balance-sheets were calculated:

Boiler.

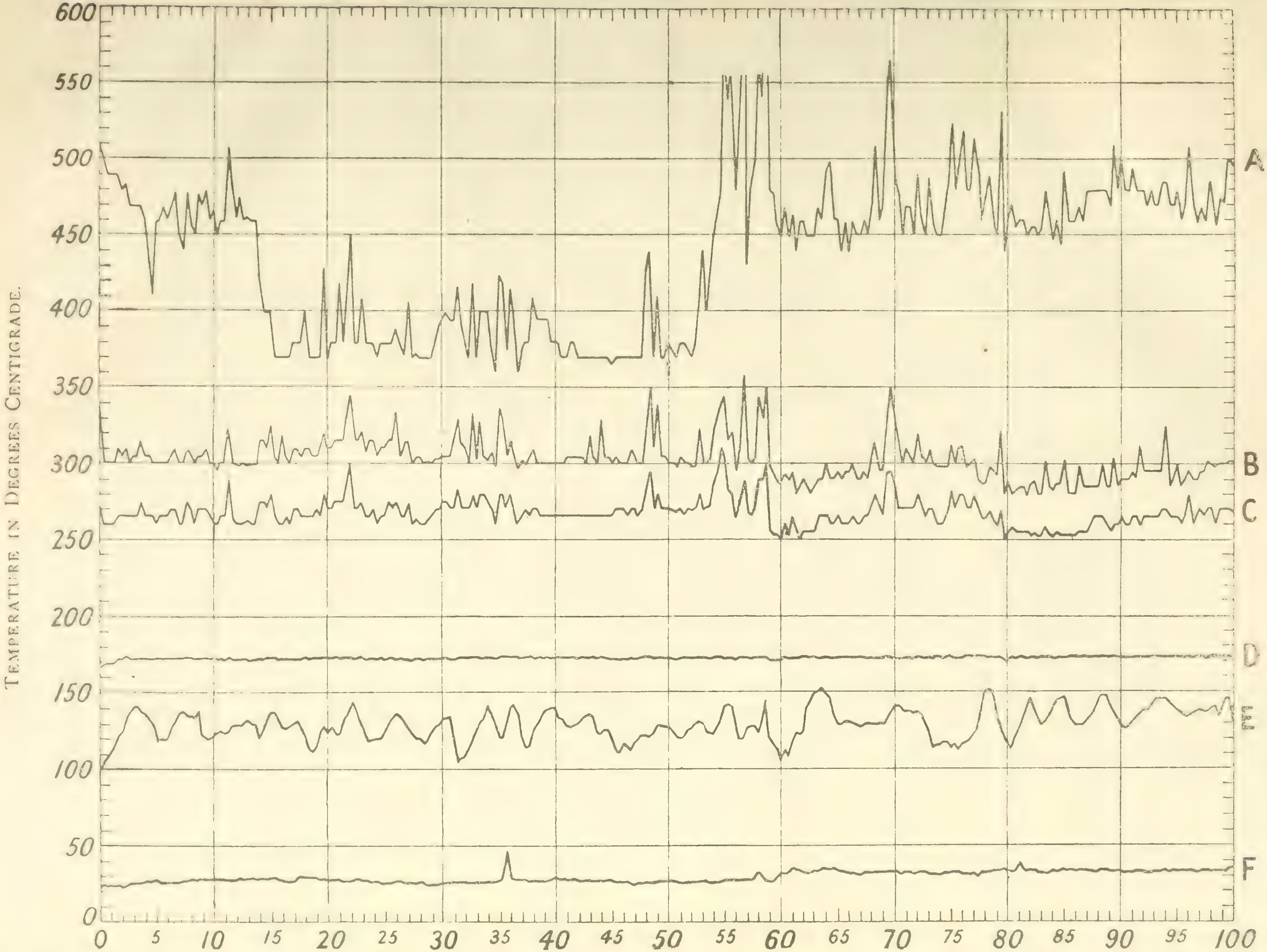
	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,081,000 ft.^{3} "products" at 504°C.	4,086,000	93.37
In 2440 lbs. hot feed at 117.8° C.	289,700	6.63
Total	4,375,700	100.00
Heat expended per hour:		
In evaporating 2440 lbs. hot feed to steam at 101 lbs. per sq. in. abs. and dryness factor 0.95	1,555,000	35.55
In 733,500 ft.^{3} "products" delivered to economiser at 254° C.	1,972,000	45.06
Other losses (by difference)	848,700	19.39
Total	4,375,700	100.00

Economiser.

Heat received per hour:		
In 733,500 ft.^{3} "products" at 254°C.	1,972,000	98.58
In 2440 lbs. cold feed at 11.6°C.	28,310	1.42
Total	2,000,310	100.00
Heat expended per hour:		
In heating 2440 lbs. cold feed to 117.8°C.	289,710	14.48
In 615,200 ft.^{3} "products" discharged at 169°C.	1,292,000	64.60
Other losses (by difference)	418,610	20.92
Total	2,000,310	100.00

Efficiencies.

$$\text{Boiler} = \frac{1,555,000 \times 100}{4,375,000} = 35.55 \text{ per cent.}$$



BABCOCK BOILER 'N.' G.S.B.—Duration of test, 6th to 11th May 1918.

A.—Temperature of gas entering boiler.
B.—Temperature of gas entering economiser
C.—Temperature of gas leaving economiser.
D.—Temperature of steam in boiler.
E.—Temperature of feed water entering boiler
F.—Temperature of feed water entering economiser

—Thomas B. Mackenzie.

$$\text{[illegible]} \quad \frac{289{,}700 \times 100}{2{,}000{,}310} \quad 14.48 \text{ per cent.}$$

$$\text{Over all} \quad \frac{1{,}555{,}000 \times 100}{4{,}114{,}310} = 37.80 \text{ per cent.}$$

The fan absorbed 14.3 Board of Trade units of electricity per hour.

During the trials the furnace was working at the rate of 2.25 tons of ingots per hour. The amount of steam generated was therefore $\frac{2440 \text{ lbs. per hour}}{2.25 \text{ tons per hour}} =$ 1084 lbs. per ton of ingots.

If the steam generated per hour had been used in a modern turbine with a good vacuum to generate electric energy the amount generated would have been:

	158.0 B.T. Units.
Deduct amount used by fan	14.3 B.T. Units.
Leaving a net amount of energy available for outside work of	143.7 B.T. Units.

Assuming boiler fuel to have a calorific value of 6700 lb. calories per pound, and that ordinary steelwork boilers have an efficiency of 65 per cent, the fuel equivalent of the steam generated was 357 lbs. per hour, equal to 158.7 lbs. per ton of ingots.

If we divide the net amount of electric energy available for outside work by the rate of production of ingots, we obtain 63,86 Board of Trade units per ton, an amount which should be sufficient to roll the steel produced by the furnace.

These results having demonstrated that the author's arrangement was quite practicable and did not in any way interfere with the furnace output, it was decided to provide a new smelting-shop in process of erection and containing open-hearth furnaces of 45 tons nominal capacity with similar equipment.

The equipment consists, for each furnace, of a Babcock and Wilcox water-tube boiler having a heating surface of 1827 square feet, a Green's economiser having a heating surface of 960 square feet, and a Keith and Blackman fan with an impeller 30 inches diameter, driven by a variable speed direct current motor of 40 brake-horse-power.

The fans discharge through short funnels direct into the atmosphere. The furnace chimneys have disc plate dampers at the top, which are kept nearly closed when the boilers, economisers, and fans are in operation.

There are two reasons why the dampers are not closed fully, one being that the boilers and fans are rather small, and the other being a fear lest an explosive mixture would become pocketed in the chimney at each reversal of the furnace with the risk of ''kicks' taking place which might cause damage to the plant.

This plant was finished and put to work shortly before the war broke out, so that no tests were made of there performance. Since the war the author has been jointly responsible for adding seven boilers and fans to old furnaces and ten to new furnaces, and it is unfortunate that the theory was not developed, as, had it been done, larger boilers would have been used and more steam obtained.

A number of tests have now been run, details of which are given below:

I.—Waste-Heat Boiler on Open-Hearth Furnace of 45 Tons Nominal Capacity.

Boiler—Type: Babcock & Wilcox water-tube. Heating surface, 1827 square feet.
Economiser—Type: Green's patent. Heating surface, 960 square feet.
Fan—Type: Keith & Blackman multi-vane. Diameter of impeller, 30 inches. Speed, 580 r.p.m.
Duration of test, 99 hours.
Readings taken at 20-minute intervals.

The following are the average values of the data observed:

Temperature of "products" entering boiler....	585.3°C.
Temperature of "products" entering economiser	273°C.
Temperature of "products" entering fan	181.6°C.
Temperature of feed entering economiser	6.95°C.
Temperature of feed entering boiler	120.6°C.
Steam pressure per sq. in. abs.	119 lbs.
Dryness factor of steam (assumed)	0.95 lbs
Total water evaporated	393,251 lbs.
Water evaporated per hour	3972 lbs.
Water evaporated per hour "from and at"......	4604 lbs.
Evaporation "from and at" per sq. ft. H.S.....	2.52 lbs.
Electric energy used by fan (kw. hours)	26.40 lbs.
Equivalent to (brake-horse-power)	31.85 lbs.
Draft entering boiler	0.91 in. W.G.
Draft between boiler and economiser	2.43 in. W.G.
Draft entering fan	3.43 in. W.G.
Probable volume of "products" at s.t.p. passing through boiler, economiser, and fan per hour	400,000 ft.³
Heat contents of "products" entering boiler at 585.3°C. in lb. calories per cubic feet s.t.p..	12.56
Heat contents of "products" entering economiser at 273°C. in lb. calories per cubic feet s.t.p.	5.59
Heat contents of "products" entering fan at 181.6°C. in lb. calories per cubic ft. s.t.p....	3.66

From the above data the following heat balance-sheets have been calculated, viz.:

Boiler.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,258,000 ft.³ "products" at 585.3°C	5,060,000	91.32
In 3972 lbs. hot feed at 120.6°C.	481,400	8.68
Total	5,541,400	100.00
Heat expended per hour:		
In evaporating 3972 lbs. hot feed to steam at 119 lbs. per sq. in. abs. and dryness factor 0.95	2,540,000	45.83
In 800,000 feet³ "products" delivered to economiser at 273°C.	2,237,200	40.38
Other losses (by difference)	764,200	13.79
Total	5,541,400	100.00

Economiser.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 800,000 ft.³ "products" at 273°C.....	2,237,200	98.77
In 3972 lbs. cold feed at 6.95°C.	27,800	1.23
Total	2,265,000	100.00
Heat expended per hour:		
In heating 3972 lbs. cold feed to 120.6°C.	481,400	21.25
In 666,200 ft.³ "products" discharged at 181.6°C.	1,464,400	64.66
Other losses (by difference)	319,200	14.09
Total	2,265,000	100.00

Efficiencies.

$$\text{Boiler} = \frac{2{,}540{,}000 \times 100}{5{,}541{,}400} = 45.83 \text{ per cent.}$$

$$\text{Economiser} = \frac{481{,}400 \times 100}{2{,}265{,}000} = 21.25 \text{ per cent.}$$

$$\text{Over all} \quad \frac{2,540,000 \times 100}{5,087,800} \quad 49.91 \text{ per cent.}$$

Theoretical power required to move 666,200 cubic feet of "products" per hour at a temperature of 181.6°C., with a suction of 3.43 inches, water-gauge is equal to 6 brake-horse-power. The efficiency of the fan is therefore:

$$\frac{\text{Theoretical horse-power} = 6.0}{\text{Actual Horse-power taken} = 31.85} = 18.84 \text{ per cent.}$$

During the test the furnace was working at the rate of 4.18 tons of ingots per hour. The amount of steam generated was therefore:

$$\frac{3972 \text{ lbs. per hour}}{4.18 \text{ tons per hour}} = 949.3 \text{ lbs. per ton of ingots.}$$

If the steam generated were used in a modern turbine with a good vacuum to generate electric energy the amount would be:

	= 253.2 kw.-hours
Deduct amount used by fan..........	= 26.4 kw.-hours
Leaving a net amount	= 226.8 kw.-hours

per furnace which is available for general purposes, equivalent to 54.2 kw.-hours per ton of ingots.

Making the same assumptions as before with regard to boiler fuel and efficiency, the fuel equivalent of the steam generated is 583.2 lbs. per hour per furnace, equal to 139.4 lbs. per ton of ingots.

Note.—As the damper on top of chimney was open slightly, the products of combustion accounted for in the test do not represent the whole amount available. Had the boiler been larger, more steam could certainly have been generated.

II. Waste-Heat Boiler on Open-Hearth Furnace of 100 Tons Nominal Capacity.

Boiler—Type: Babcock & Wilcox water-tube. Heating surface, 2193 square feet.
Economiser—Type: Green's patent. Heating surface, 1200 square feet.
Fan—Type: "Sirocco" multi-vane. Diameter of impeller, 50 inches. Speed, 480 r.p.m.
Duration of test, 77 1-3 hours.
Readings taken at 20-minute intervals.

The following are the average values of the data observed:

Temperature of "products" entering boiler....	422.1°C.
Temperature of "products" entering economiser	232.4°C.
Temperature of "products" entering fan......	184.4°C.
Temperature of feed entering economiser......	40.8°C.
Temperature of feed entering boiler	133.5°C.
Steam pressure per sq. in. abs.	74 lbs.
Dryness factor of steam (assumed)	0.95
Total water evaporated	228,306 lbs.
Water evaporated per hour	3,728 lbs.
Water evaporated per hour "from and at"....	4,045 lbs.
Evaporation "from and at" per sq. ft. H.S.......	1.84 lbs.
Electric energy used by fan (kw.-hours).......	24.2
Equivalent to (brake-horse-power)	32.4
Draft entering boiler	1.60 W.G.
Draft entering economiser	3.05 W.G.
Draft entering fan	3.15 W.G.
Probable volume of "products" at s.t.p. passing through boiler, economiser, and fan per hour	600,000 ft.³
Heat contents of "products" entering boiler at 422.1°C. in lb. calories per cub. ft. s.t.p.....	8.87
Heat contents of "products" entering economiser at 232.4°C. in lb. calories per cub. ft. s.t.p.	4.73
Heat contents of "products" entering fan at 184.4°C. in lb. calories per cub. ft. s.t.p....	3.72

From the above data the following heat balance-sheets have been calculated, viz.:

Boiler.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,528,000 ft.³ "products" at 422.1°C.	5,322,000	91.37
In 3728 lbs. hot feed at 133.5°C.	503,100	8.63
Total	5,825,100	100.00
Heat expended per hour:		
In evaporating 3728 lbs. hot feed to steam at 74 lbs. abs. and dryness factor 0.95	2,360,000	40.52
In 1,111,000 ft.³ "products" to economizer at 232.4°C.	2,838,000	48.72
Other losses (by difference)	627,100	10.76
Total	5,825,100	100.00

Economiser.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,111,000 ft.³ "products" at 232.4°C...	2,838,000	94.91
In 3728 lbs. cold feed at 40.8°C.	152,400	5.09
Total	2,990,400	100.00
Heat expended per hour:		
In heating 3728 lbs. cold feed to 232.4°C.	503,100	15.34
In 1,006,000 ft.³ "products" discharged at 184.4°C.	2,232,000	79.11
Other losses (by difference)	255,300	5.55
Total	2,990,400	100.00

Efficiencies.

$$\text{Boiler} = \frac{2,360,000 \times 100}{2,825,100} = 40.52 \text{ per cent.}$$

$$\text{Economiser} = \frac{503,100 \times 100}{2,990,400} = 16.83 \text{ per cent.}$$

$$\text{Over all} = \frac{2,360,000 \times 100}{5,474,400} = 43.11 \text{ per cent.}$$

The theoretical power required to move 1,006,000 ft.³ "products" per hour, their volume at 184.4°C. with a suction of 3.15 inches W.G. is:

$$\frac{1,006,000 \times 3.15 \text{ inches} \times 5.2 \text{ lbs.}}{60 \times 33,000} = 8.32 \text{ B.H.P.}$$

The efficiency of the fan and motor is therefore:

$$\frac{\text{Theoretical B.H.P.} = 8.32}{\text{Actual B.H.P. taken} = 32.4} = 25.7 \text{ per cent.}$$

During the test the furnace was working at the rate of 4.36 tons of ingots per hour. The amount of steam generated was therefore:

$$\frac{3728 \text{ lbs. per hour}}{4.36 \text{ tons per hour}} = 855.3 \text{ lbs. per ton of ingots.}$$

If the steam generated was used in a modern turbine operating with a good vacuum to generate electric energy the amount generated would be:

	228.1 kw.-hours
Deduct amount used by fan	24.2 kw.-hours
Net amount available for other work	203.9 kw.-hours

equivalent to 46.77 kw.-hours per ton of ingots.

Making the same assumptions as before, with regard to boiler fuel and efficiency, the fuel equivalent of the steam generated is 542 lbs. per furnace per hour, equal to 124.4 lbs. per ton of ingots.

Note.—In this case also the fan discharges through a short funnel into the air, and the damper plate on top of chimney was slightly open, part of the "products" was therefore short circuited past the boiler. The furnace bottom gave some trouble during the run of the tests, with the result that the doors were open oftener then they should have been. A leakage of air was also discovered in the flue leading from the furnace, which partly accounts for the low temperature of the "products" reaching the boiler.

III. Waste-Heat Boiler on Open-Hearth Furnace of 60 Tons Nominal Capacity.

Boiler—Type: Babcock & Wilcox water-tubs. Heating surface, 2193 square feet.
Economiser—Type: Green's patent. Heating surface, 1200 square feet.
Fan—Type: Keith & Blackman multi-vane. Diameter of impeller, 50 inches. Speed, 240 to 320 r.p.m.
Duration of test, 93 hours.
Readings taken at 20-minute intervals.

The following are the average values of the data observed, viz.:

Temperature of "products" entering boiler....	577.2°C.
Temperature of "products" entering economiser	302.8°C.
Temperature of "products" entering fan......	171.5°C.
Temperature of feed entering economiser......	9.5°C.
Temperature of feed entering boiler	132.7°C.
Steam pressure per sq. in. abs.	88 lbs.
Dryness factor steam (assumed)	0.95 lbs.
Total water evaporated	429,213 lbs.
Water evaporated per hour	4,616 lbs.
Water evaporated per hour "from and at"......	5,296 lbs.
Evaporation "from and at" per sq. ft. H.S.....	2.41 lbs.
Electric energy used by fan (kw.-hours).......	26.4
Equivalent to (brake-horse-power)	35.4
Draft entering boiler	1.0 in. W.G.
Draft entering economiser	2.5 in. W.G.
Draft entering fan	3.0 in. W.G.
Probable volume of products reduced to s.t.p. cub. ft.	600,000
Heat contents of "products" entering boiler at 577.2°C. in lb. calories per cub. ft. s.t.p.....	12.47
Heat contents of "products" entering economiser at 302.8°C. in lb. calories per cub. ft. s.t.p.	6.24
Heat contents of "products" entering fan at 171.5°C. in lb. calories per cub. ft. s.t.p.....	3.45

From the above data the following heat balance-sheets have been calculated, viz.:—

Boiler.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,557,000 ft.³ "products" at 577.2°C.	6,235,000	90.95
In 4616 lbs. hot feed at 132.7°C.	619,400	9.05
Total	6,854,400	100.00
Heat expended per hour:		
In evaporating 4616 lbs. hot feed to steam at 88 lbs. abs. and dryness factor 0.95.	2,934,000	42.81
In 1,043,000 ft.³ "products" delivered to economiser at 296.5°C.	3,050,000	44.49
Other losses (by difference)	870,400	12.70
Total	6,854,400	100.00

Economiser.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 1,043,000 ft.³ "products" at 296.5°C.	3,050,000	98.57
In 4616 lbs. cold feed at 9.5°C.	43,900	1.43
Total	3,093,900	100.00
Heat expended per hour:		
In heating 4616 lbs. cold feed to [illegible]	[illegible]	[illegible]
In 743,200 ft.³ "products" discharged at [illegible]	[illegible]	[illegible]
Other losses (by difference)	749,500	24.23
Total	3,093,900	100.00

Efficiencies.

$$\text{Boiler} = \frac{2,934,000 \times 100}{6,854,400} = 42.81 \text{ per cent.}$$

$$\text{Economiser} = \frac{619,400 \times 100}{3,093,900} = 20.02 \text{ per cent.}$$

$$\text{Over all} = \frac{2,934,000 = 100}{6,278,900} = 46.73 \text{ per cent.}$$

The theoretical power required to move 743,200 cubic feet of "products" per hour, their volume at 171.5°C. with a suction of 3 inches W.G. is:

$$\frac{743,200 \times 3 \text{ W.G.} \times 5.2 \text{ lbs.}}{60 \times 33,000} = 5.86 \text{ B.H.P.}$$

The over all efficiency of fan and motor is therefore:

$$\frac{\text{Theoretical B.H.P.} = 5.86}{\text{Actual B.H.P. taken} = 35.4} = 16.54 \text{ per cent.}$$

During the test the furnace was working at the rate of 3.69 tons of ingots per hour. The amount of steam generated was therefore:

$$\frac{4616 \text{ lbs. per hour}}{3.69 \text{ tons per hour}} = 1252 \text{ lbs. per ton of ingots.}$$

If the steam generated was used to generate electric energy in a turbine of the type referred to above, the amount would be equal to:

	290.0 kw.-hours.
Deduct amount used by fan.......	62.4 kw.-hours.
Leaving a net amount of	263.6 kw.-hours.

per furnace which is available for general purposes, equivalent to 71.52 kw.-hours per ton of ingots.

Making the same assumptions as before with regard to boiler fuel and efficiency, the fuel equivalent of the steam generated is 673.8 lbs. per hour per furnace, equal to 182.8 lbs. per ton of ingots at the rate of output at which the furnace was working during the test.

Note.—The fan in this case also discharges direct into the air through a short funnel, and during the test the main damper was slightly open at the top of the chimney.

It will be noted that the amount of "other losses" in the economiser is excessively large, due either to the pyrometer, by which the temperatures were taken at the outlet from the economiser, reading too low, or by leakage of air about the economiser causing the assumed volume to be too low. Probably both causes were in operation.

IV. Waste-Heat Boiler on Open-Hearth Furnace of 60 Tons Nominal Capacity.

Boiler—Type: Babcock & Wilcox water-tube. Heating surface—2193 square feet.
Economiser—Type: Green's patent. Heating surface—1200 square feet.

Fan—Type: Keith & Blackman multi-vane. Diameter of impeller—50 inches. Speed—450 r.p.m.

Duration of test—99½ hours.

Readings taken at 20-minute intervals.

The readings are shown graphically on Diagram No. 1.

The following are the average values of the data observed:

Temperature of "products" entering boiler	438.9°C.
Temperature of "products" leaving boiler and entering economiser	303.7°C.
Temperature of "products" leaving economiser and entering fan	263.5°C.
Temperature of cold feed entering economiser	29.30°C.
Temperature of hot feed leaving economiser and entering boiler	129.2°C.
Steam pressure per sq. in. abs.	122.7 lbs.
Dryness factor (assumed)	0.95
Total water evaporated	471,770 lbs.
Water evaporated per hour	4,736 lbs.
Water evaporated per hour "from and at"	5,301 lbs.
Evaporation "from and at" per sq. ft. H.S.	2.42 lbs.
Electric energy used by fan (kw.-hours)	41.8
Equivalent to (brake-horse-power)	56.0
Draft entering boiler	1.00 in. W.G.
Draft between boiler and economiser	3.75 in. W.G.
Draft entering fan	5.75 in. W.G.
Probable volume of products passing through boiler, economiser, and fan per hour reduced to standard temperature and pressure	950,000 ft.³
Heat contents of "products" entering boiler at 438.9°C. in lb. calories per cub. ft. s.t.p.	9.26
Heat contents of "products" entering economiser at 303.7°C. in lb. calories per cub. ft. s.t.p.	6.26
Heat contents of "products" entering fan at 263.5°C. in lb. calories per cub. ft. s.t.p.	5.39

From the above data the following heat balance-sheets have been calculated, viz.:

Boiler.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 2,477,000 ft.³ "products" at 438.9°C.	8,792,000	93.46
In 4736 lbs. hot feed at 129.2°C.	615,600	6.54
Total	9,407,600	100.00
Heat expended per hour:		
In evaporating 4736 lbs. hot feed to steam at 122.7 lbs. abs. and dryness factor 0.95	3,031,000	32,21
In 2,006,000 ft.³ "products" to economiser at 303.7°C.	5,947,000	63.22
Other losses (by difference)	429,600	4.57
Total	9,407,600	100.00

Economiser.

	Lb. Calories.	Per Cent.
Heat received per hour:		
In 2,006,000 ft.³ "products" at 303.7°C.	5,947,000	97.72
In 4736 lbs. cold feed at 29.3°C.	138,800	2.28
Total	6,085,800	100.00
Heat expended per hour:		
In heating 4736 lbs. cold feed to 129.2°C.	615,600	10.12
In 1,866,000 ft.³ "products" discharged at 263.5°C.	5,121,000	84.16
Other losses (by difference)	349,200	5.72
Total	6,085,800	100.00

Efficiencies.

$$\text{Boiler} = \frac{3,031,000 \times 100}{9,407,600} = 32.21 \text{ per cent.}$$

$$\text{Economiser} = \frac{615,600 \times 100}{6,085,800} = 10.12 \text{ per cent.}$$

$$\text{Over all} = \frac{3,031,000 \times 100}{8,930,800} = 33.93 \text{ per cent.}$$

The theoretical power required to move 1,866,000 ft.³ "products" per hour, their volume at 263.5°C. with a suction of 5.75 inches W.G. is:

$$\frac{1,866,000 \text{ ft.}^3 \times 5.75 \text{ ins. W.G.} \times 5.2 \text{ lbs.}}{60 \times 33,000} = 28.18 \text{ B.H.P.}$$

The over all efficiency of fan and motor is therefore:

$$\frac{\text{Theoretical B.H.P.} = 28.18}{\text{Actual B.H.P. taken} = 56.02} = 50.28 \text{ per cent.}$$

During the test the furnace was working at the rate of 5.94 tons of ingots per hour. The amount of steam generated was therefore:

$$\frac{4736 \text{ lbs. per hour}}{5.94 \text{ tons per hour}} = 796.9 \text{ lbs. per ton of ingots.}$$

If the steam generated was used to generate electric energy in a turbine of the type referred to above, the amount would be equal to

	320.2 kw.-hours
Deduct amount taken by fan	41.8 kw.-hours
Leaving a net amount of	278.4 kw.-hours

per furnace which is available for general purposes, equivalent to 46.81 kw.-hours per ton of ingots.

Making the same assumptions as before with regard to boiler fuel and efficiency, the fuel equivalent of the steam generated is 695.8 lbs. per furnace per hour, equal to 117 lbs. per ton of ingots at the rate of output at which the furnace was working during the test.

Note.—The fan in this case deals with whole products of combustion, and after drawing them over the heating surfaces of boiler and economiser discharges them back into the chimney.

It will be noted that the efficiencies both of boiler and economiser are very low. This is due to the fact that they are too small for the volume of "products" passing through them.

That the boiler was working quite well is proven by the fact that it evaporated more water than No. III., although the temperature of the "products" was lower. The economiser, on the other hand, was not doing well, probably owing to the fact that it was working with hard water from a loch, with the result that the pipes may have been coated with scale. The high suction required at the fan inlet will also be noted due to the boiler being too small, and therefore the spaces between the tubes not being large enough for the volume of "products" being drawn through.

At the time of writing alterations are being made in the position of the baffles which will enable the "products" to flow more freely through.

A typical analysis of the producer-gas supplied to the furnaces during the above tests is:

	Per Cent.
CO_2	8.2
CO	20.8
CH_4	3.4
H_2	13.0
N_2	54.6
	100.0

From which the amount of air and volume of products of combustion, with the theoretical amount of air required for complete combustion, can be calculated. The result is shown in the following table:

Gas Ft.^{3} per Ft.^{3}.	Air for Complete Combustion.	Products of Combustion.		
		CO_2.	H_2O.	N_2.
CO_2 : 0·082	...	0·082	...	...
CO : 0·208	O_2 : 0·104	0·208	...	...
CH_4 : 0·034	O_2 : 0·068	0·034	0·068	...
H_2 : 0·130	O_2 : 0·065	...	0·130	...
N_2 : 0·546	N_2 : 0·902	...	...	1·448
1·000	1·139	0·324	0·198	1·448

1.139 volumes of air are therefore required for the theoretical combustion of 1 cubic foot of producer-gas, and will yield 1.97 cubic feet of products of combustion all reduced to s.t.p.

A typical analysis of the waste gases entering boiler, estimated on a dry sample, is:

	Per Cent.
CO_2	11.2
O_2	7.2
N_2	81.6
	100.0

Replacing the water vapour and separating from the N_2 that entering with the excess air, the volumes and percentages are in 1 cubic foot of the products:

Gas.	Cubic Foot per Cubic Foot.	Per Cent.
CO_2	0·1127	11·27
H_2O	0·0688	6·88
N_2	0·4996	49·96
Excess air . . .	0·3189	31·89
	1·0000	100·000

The total volume of the products of combustion are with this amount of excess air 2.89 times that of the producer-gas when they are at the same temperature and pressure.

The mean specific heats of the gases in lb. calories per cubic foot at s.t.p. have been calculated by the following Malard-Le Chatelier formulae:

$$\begin{aligned} Co_2 &= 0.023 + 0.000014t^\circ \text{ C.} \\ H_2O &= 0.021 + 0.000009t^\circ \text{ C.} \\ O_2 \text{ and } N_2 &= 0.0189 + 0.0000017t^\circ \text{ C.} \end{aligned}$$

To facilitate the use of these formulae Diagram No. 2 is appended, on which the temperatures of the gases and quantities of heat in lb. calories are plotted as coordinates. The curved lines give the values for the various gases named. To use the diagram all that is necessary is to multiply the fraction of a cubic foot of the particular gas in 1 cubic foot of the mixture by the value of the heat contents on the vertical scale opposite the point where a vertical from the temperature cuts the curve of the gas required, when the sum of the products will give the heat contents of the mixture in lb. calories per cubic foot.

The calorific value of the producer-gas is 78.91 lb. calories per cubic foot, and its volume about 150,000 cubic foot at s.t.p. per ton of fuel.

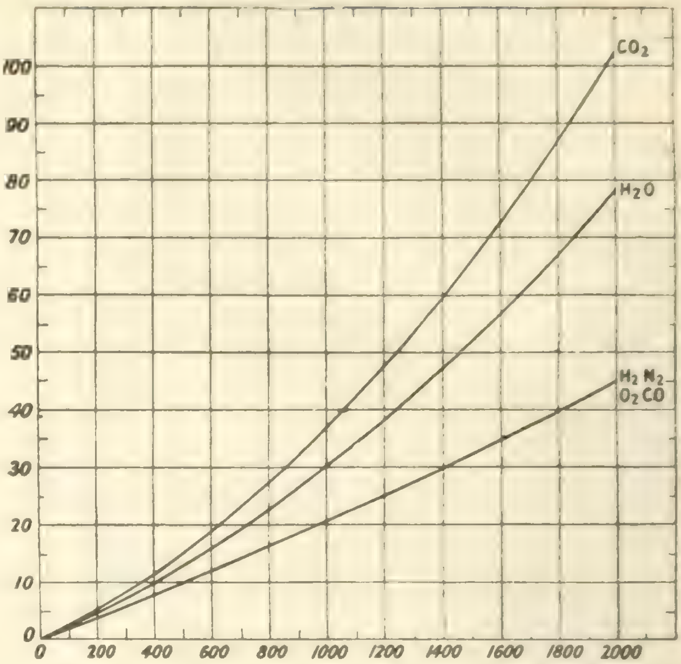


DIAGRAM No. 2.—Heat Contents of Gases at varying Temperature and Constant Pressure in Pound Calories per Ft.^{3}

The furnace, when the whole volume of gas passed through the boiler, was delivering 950,000 ft.^{3} of products per hour at s.t.p., and was producing ingots at the rate of 5.94 tons per hour; its fuel consumption was therefore:

$$\frac{950{,}000 \text{ ft.}^3 \text{ per hour}}{7500 \text{ ft.}^3 \text{ per cwt.} \times 5.94 \times 2.89} = 7.377 \text{ cwt. per ton of ingots.}$$

As the furnace was working on cold stock, and the fuel contains on an average 13.5 per cent ash and 9.7 per cent water, the result is fairly good.

Consideration may now be given to the theoretical principles which govern the operation of waste-heat boilers, making use of the data which have been observed in connection with the above tests to determine the constants, to enable formulae to be constructed for fixing area of heating surface, etc.

Let:

0_1 = Quantity of heat per ft.^{3} in products entering boiler.

0_2 = Quantity of heat per ft.^{3} in products leaving boiler and entering economiser.

0_3 = Quantity of heat per ft.^{3} in products leaving economiser.

V = Volume of products per hour reduced to s.t.p.

H_1 = Area of boiler heating surface in square feet.

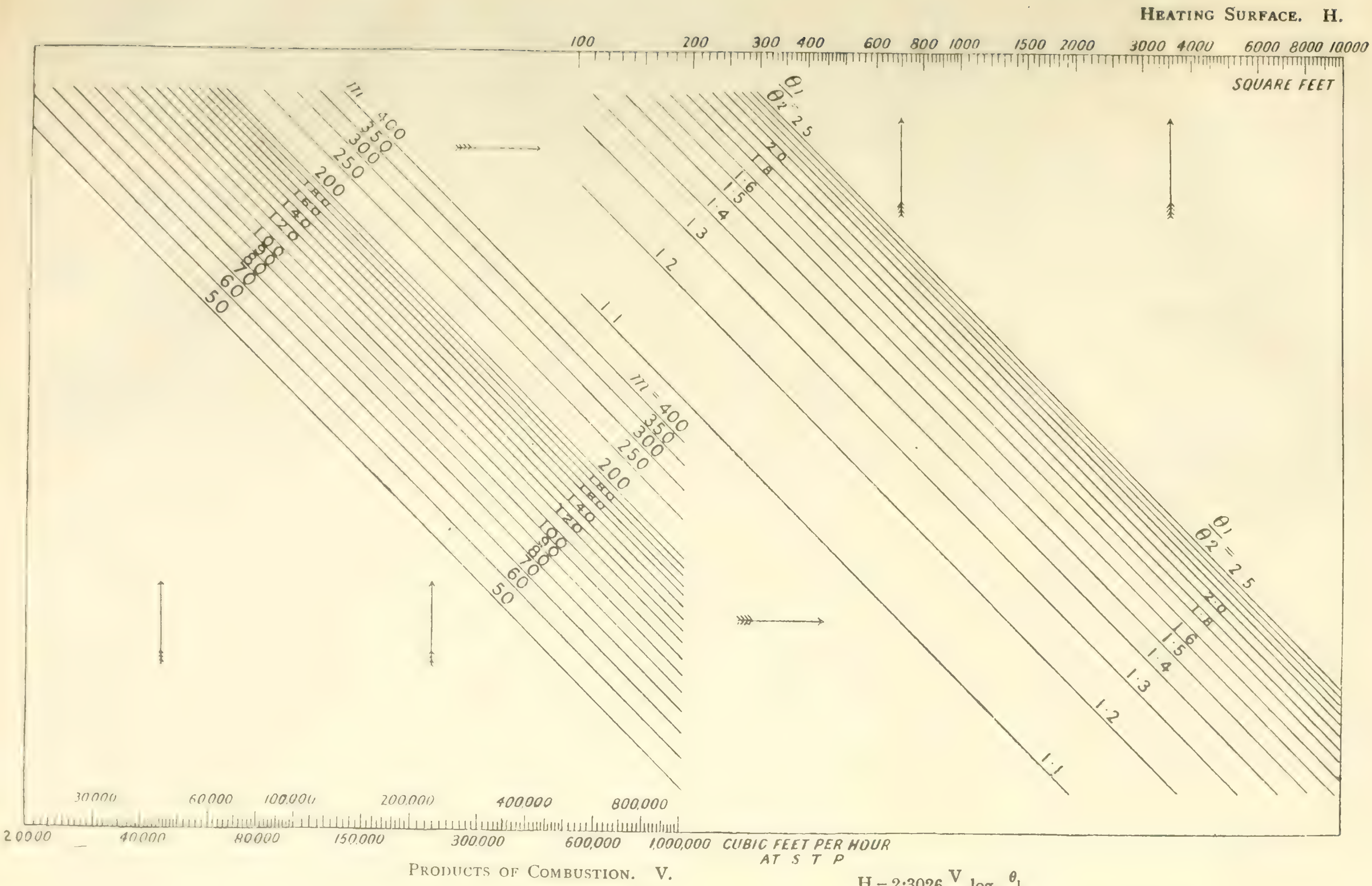
H_2 = Area of economiser heating surface in square feet.

M_1 = Modulus of heat transmission through boiler H.S.

M_2 = Modulus of heat transmission through economiser H.S.

The amount of heat transmitted through an element of heating surface dH. will be: dH.M.0.

The volume of products flowing past this place in an hour is V cubic feet, and the heat lost by it will be: V.$d0$.



$$H = 2{\cdot}3026 \frac{V}{m} \log_{10} \frac{\theta_1}{\theta_2}.$$

Where H = Heating surface in square feet.
V = Volume of products of combustion in cu. ft. per hr.
θ_1 = Heat contents per cu. ft. of products entering boiler.
θ_2 = ,, ,, ,, ,, leaving ,,
m = Modulus of heat transmission through heating surface.

Thomas B. Mackenzie.

Chart Showing Relation of Products of Combustion to Heating Surface in Water-tube Boilers of the Babcock Type.

When steady conditions have been attained these expressions must be equal to each other, therefore:

$dH.M.\theta = - V.d\theta$, equal to:

$$\frac{dH}{d\theta} = -\frac{V}{M \cdot \theta} \quad . \quad . \quad . \quad (1)$$

Integrating (1) there is obtained:

$$H = -\frac{V}{M}.\log \theta + \text{const.} \quad . \quad (2)^{1}$$

To determine the constant make H = 0, at which place the entrance to the boiler, $\theta = \theta_1$ and the constant is:

$$\frac{V}{M}.\log \theta_1.$$

Taking the integral over the whole heating surface from the entrance where $\theta = \theta_1$, to the outlet when $\theta = \theta_2$, there is obtained the equation:

$$\frac{HM}{V} = \log \frac{\theta_1}{\theta_2} \quad . \quad . \quad . \quad . \quad (3)$$

Having observed V, H, θ_1, and θ_2, the modulus M_1 can be obtained from the equation:

$$M_1 = \frac{V}{H}.\log \frac{\theta}{\theta_2} \quad . \quad . \quad . \quad (4)$$

Finally having found M_1 and fixed on the ratio $\frac{\theta_1}{\theta_2}$, the heating surface of any boiler to deal with V cubic feet of products per hour can be calculated from the equation:

$$H = \frac{V}{M_1}.\log \frac{\theta_1}{\theta_2} \quad . \quad . \quad (5)$$

The same argument applies to the economiser except M_2, θ_2, and θ_3 are substituted for M_1, θ_1, and θ_2.

The modulus for boiler M_1 and that for economiser M_2 have been calculated from the data furnished by the tests recorded above with the results shown in the following table, viz.:

Test.	θ_1 Lb. Cal.	θ_2 Lb. Cal.	θ_3 Lb. Cal.	Boiler.		Economiser.	
				$\frac{\theta_1}{\theta_2}$.	M_1.	$\frac{\theta_2}{\theta_3}$.	M_2.
Exp.	10·75	5·19	3·40	2·07	170·4	1·53	224·5
I.	12·65	5·59	3·66	2·26	178·3	1·53	177·2
II.	8·87	4·73	3·72	1·88	172·8	1·27	119·5
III.	12·47	6·10	3·45	2·04	162·6	1·77	237·9
IV.	9·26	6·26	5·39	1·48	169·8	1·16	117·5

It will be noted that the modulus, in the case of the boilers, is fairly consistent, the average value being 170.8. If it be taken as 171 equation 5 can be put in the form:

$$\frac{\text{Volume of products per hour at s.t.p.}}{171} \times \log \left\{\frac{\theta_1}{\theta_2}\right\}$$
= Heating surface of boiler in sq. ft. (6)

In the case of the economisers the results are rather inconsistent. It is, however, interesting to note that in Test III., which gives the highest value of M_2, the economiser was new and was being supplied with Loch Katrine water, which is ideal for boiler purposes. The next highest is the experimental one when the economiser was also new and supplied with Motherwell water, which is a fairly good water. The third highest, Test No. 1, was also supplied with Motherwell water, but the economiser had been in use for some time, so that the pipes were probably somewhat scaled. The two lowest results, Tests II. and IV., are both fed with water from Kilbirnie Loch in Ayrshire, and the water is rather hard.

If the average of the three highest values be taken we obtain the value 213.2, or in round figures 210. Equation 5 can then be put in the form:

$$\frac{\text{Volume of products per hour at s.t.p.}}{210} \times \log \left\{\frac{\theta_2}{\theta_3}\right\}$$
= Heating surface of economiser in sq. ft. (7)

To enable the results of these equations to be found by inspection Diagram No. 3, Plate II., has been prepared, on which will be found a scale at the bottom left-hand side giving values of volume of products per hour; the diagonal lines above this scale give different values of the Modulus M. To the right of these are another series of diagonal lines giving different values of the ratio $\frac{\theta_1}{\theta_2}$ or $\frac{\theta_2}{\theta_3}$, as the case may be, whilst at the top right-hand side is a scale from which the appropriate area of heating surface of boiler or economiser can be read off.

The method of using the diagram is to select on the scale of volumes the value which applies to the case, pass vertically upwards to where the line cuts the value chosen as the modulus, then horizontally across to the intersection of the line giving the value chosen for the ratio of heat contents, then vertically upwards to the scale of heating surfaces, when the value required will be found.

Consideration may now be given to the rate of heat transmission through the boiler-heating surface. This will depend on two factors:

(*a*) The difference of temperature between the average heat of the hot products in their passage through the boiler chamber and the water inside the boiler, constituting the heat gradient through the thickness of the material forming the heating surface.

(*b*) The speed of flow of the hot products over the heating surface.

It will be assumed, what is probably correct, that when the speed of flow is constant the rate of transmission through the heating surface of the boiler will vary directly as the heat gradient, and that when the heat gradient is constant the rate of transmission will vary directly as the speed of flow of the products. It will also be assumed that the figure obtained by dividing the average volume of products passing through the boiler chamber by the area of heating surface will be proportional, with boilers all of the same type, to the speed of flow. With these assumptions the following table has been calculated:

1. Test.	2. Heat Gradient.	3. Vol. per min. H.S.	4. Product of 2 and 3.	5. Heat Transmission from Test.	6. Heat Transmission from Formula
				Lb. Cal.	Lb. Cal.
Exp. . .	214·3° C.	9·34	2002	981	1184
I. . .	257·4° C.	9·39	2416	1390	1258
II. . .	174·7° C.	10·02	1753	1876	1135
III. . .	280·8° C.	9·88	2775	1339	1314
IV. . .	198·7° C.	17·04	3386	1382	1401

[1] The logs are the Naperian or natural logarithms.

Let—

G = Heat gradient as defined above.

S = Volume of products per minute divided by area of heating surface as defined above.

P = G × S.

T = Heat transmitted through heating surface in lb. calories per square foot per hour.

It will then be found that if the common logarithms to base 10 of P and T are plotted as co-ordinates the points will lie in a cluster through which a straight line can be drawn inclined to the horizontal at an angle whose tangent is 0.32 and which will cut the vertical axis at 2.017, from which the following equation can be derived:

$$T = 104 \times (P)^{0.32} \qquad . \qquad . \qquad (8)$$

This equation can be written—

$$\text{Log}_{10} T = 2.017 + 0.32 \log_{10} P \qquad . \qquad (9)$$

in which form it is easily solved with the aid of a table of logarithms.

Values of T have been calculated for the several tests recorded in the first section of this paper and tabulated in column 6 of the foregoing table against the values from the experimental results.

It will be noted that the experimental boiler and No. 1 do not agree very closely, but that the others are in fairly close agreement.

More experimental data are, however, required over a wider range of values, and it is hoped that any of the members who may have such data in their possession will be good enough to communicate them.

It will be noted that in fixing the heating surface we determine the ratio of heat contents of the products entering and leaving the boiler chamber, whilst in determining the heat transmitted per square foot of the heating surface what we require to know is the temperature entering and leaving the boiler chamber. The temperature entering will, in the case of an existing furnace, be obtainable by actual measurement with a pyrometer, and in the case of a new furnace can be approximated to from the known results obtained with similar furnaces.

To obtai nthe temperature of the products leaving the chamber, having fixed upon the ratio of $\frac{\theta_1}{\theta_2}$ it will be useful to have an equation connecting temperature with heat contents in a form convenient for use.

If the analysis of waste products previously given be taken as a good average sample, the equation connecting temperature with heat contents is—

$0.1951t + 0.000{,}003{,}6t^2 = \theta$ = heat contents per cu. ft.

This quadratic equation is not particularly convenient for use, but if values are calculated, and their logarithms plotted with the logarithms of the temperature as co-ordinates an equation is obtained which is easily solved with the aid of a table of logarithms, it is—

$$\text{Log } t° \text{ Cent.} = 0.939\ (1.846 + \log \theta) \qquad (10)$$

The following table gives values of heat contents corresponding to the most useful temperatures likely to occur in waste-heat boiler practice, and also the results obtained from equation 10.

Temperature Cent.	Heat Contents per Cubic Foot θ.	Temperature from Equation 10.
100°	1·987	103·1°
200°	4·016	202·2°
300°	6·176	299·1°
400°	8·379	398·4
500°	10·654	499·1°
600°	12·998	599·4°
700°	15·424	708·3
800°	17·912	813·[illegible]

Another point which is of interest is the question of the resistance to flow of the hot products through between the boiler tubes, and what suction, measured in water gauge, must be provided to overcome the resistance and still leave enough pull at the entrance to the boiler to maintain the draft necessary for the efficient operation of the melting furnace.

The experience which has been gained in the past has practically been with boilers fired with either solid, liquid, or gaseous fuel in which there was actual combustion under the boiler.

Under these circumstances the volume of the produts of combustion are not so large as where the whole products from a large smelting furnace have to be dealt with.

Making the same assumption which was made with regard to the rate of heat transmission, viz., that the rate of flow of the products is a function of the volume per minute divided by the heating surface and calling this $f\ (v)$, it would appear that a simple linear equation of the form:

$$0.16\, f(v) = \text{suction in inches W.G.} \qquad (11)$$

will give results closely agreeing with the limited number of observations available, as the following table will show:

$f(v)$.	Suction entering Boiler.	Suction leaving Boiler.	Difference.	From Formula
	W.G.	W.G.	W.G.	W.G.
9·39	0·91 inches	2·43 inches	1·52 inches	1·50 inches
9·88	1·60 ,,	3·05 ,,	1·45 ,,	1·58 ,,
10·02	1·00 ,,	2·50 ,,	1·50 ,,	1·60 ,,
17·04	1·00 ,,	3·75 ,,	2·75 ,,	2·72 ,,

More experimental data are, however, required before the curve can be accurately determined.

As none either of the boilers or economisers which were tested were prepared in any way for the test, but were taken in their actual working conditions, some of the discrepancies between the actual and the calculated results are no doubt due to the state of the tube surface as to freedom from deposit on the outside and scale inside.

None of the boilers above referred to were provided with superheaters, but there is no doubt that such could be quite well applied with the advantage of obtaining steam containing a greater store of energy.

With regard to the actual setting of the boiler, economiser, and fan, it is important to keep the passages short and direct, avoiding all quick bends, also to do everything possible to prevent air leakage. There must also be provided plenty of explosion doors, which must be air-tight when closed. So important is the prevention of air leakage that the author is of opinion that where waste-heat boilers are to be used the air valves of the furnace should be water-sealed, as the butterfly valves usually used for air are far from being tight.

A good lay out of the plant is shown in Fig. 1, from which it will be seen that a three-way water-sealed valve of the drum type is arranged to send the products either to the boiler or direct to the chimney, and that the fan discharges back into the chimney, as even at their low temperature, after passing over boiler and economiser, some pull could be got from the chimney to help the fan.

Collecting the more important results of the tests detailed in the first part of this paper, the following table is obtained:

Item.	Exp.	I.	II.	III.	IV
Heat usefully employed in boiler, lb. cal.	1,555,000	2,540,000	2,360,000	2.934,000	3,031,000
Weight of steam of dryness factor 0.95 generated per hour, lbs.	2440	3792	3728	4616	4736
Weight of steam per ton of ingots, lbs.	1084	[illegible]	[illegible]	1252	[illegible]

The average of the above weights of steam per ton of ingots is 987.5 lbs. As only one of the boilers in the above tests was receiving all the waste products of combustion, and it was too small to deal properly with the amount, and the others were only using about two-thirds of the products from their respective furnaces, there seems reasons to believe that at least 1200 lbs. of steam per ton of ingots would have been obtained under more favourable conditions.

Experience has shown that in a steelworks making plates and bars, and in which the power plant is not particularly up to date, most of the mill engines being of the simple high-pressure type, the shears being similarly driven, and even some of the live roller racks being driven by small and wasteful engines, whilst the pipe ranges are of considerable length, the steam consumed works out at 3,200 lbs. per ton of ingots. Even in such a case, therefore, the saving in boiler fuel which could be effected by the use of waste-heat boilers on the smelting furnaces would be 43.75 per cent. Another source of steam, which has not been dealt with in this paper, is the waste heat from the reheating furnaces. The volume of products would be less per furnace, but from some tests made it would appear that the temperature is higher. A very conservative estimate will therefore be, that under the conditions named above, a saving of 50 per cent in boiler fuel can be made by utilising heat presently, in nearly every case, going to waste.

More experimental data are, however, necessary, and it is to be hoped that all of the members who may have such in their possession will, in the interests of engineering science, communicate them, so that the deductions which have been drawn from those herein recorded may be either confirmed, or, where necessary, modified.

In conclusion, the author desires to thank Mr. A. Maclaren, B.Sc., for his assistance in superintending the tests on boilers Nos. I. to IV. inclusive, and for his help in making the diagrams attached to this paper, and to Mr Thomas, the boiler-shop manager at Dalzell Steel and Iron Works, for his assistance during the installation and testing of the experimental boiler, and for many useful hints in connection with the remaining boilers.

The following papers have already appeared dealing with the subject of waste-heat boilers, viz.:

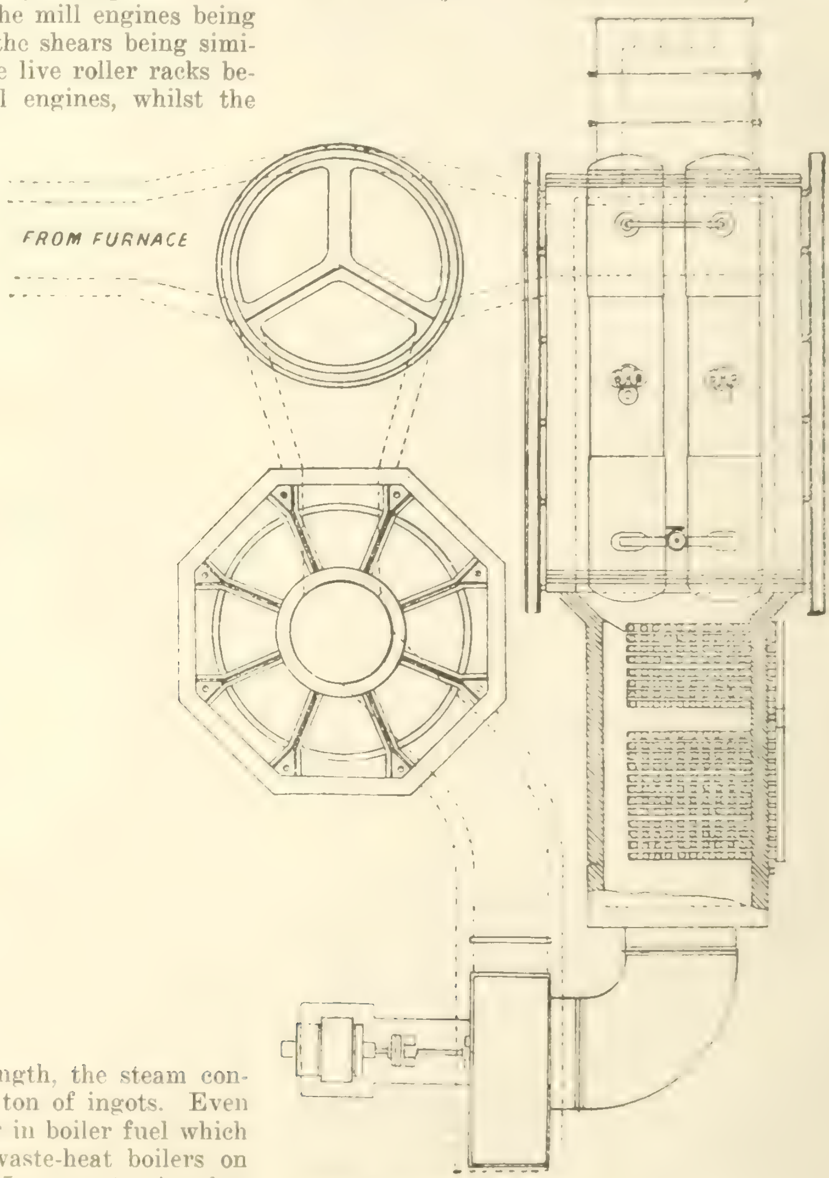


Fig. 1.—Lay Out of Plant.

Where Read and Date.	Title.	Author.
I. E. & S. Scot., Glasgow, 21/3/1911.	On Means for Economising Fuel and Utilising Waste Heat in Malleable Iron and Steel Works.	Thomas B. Mackenzie.
Am. I. & S. I., New York, 28/5/1915.	Waste-Heat Boilers for Open-Hearth Furnaces.	C. J. Bacon.
Am. Soc. M.E., New York, 5 to 8/12/16.	The Utilisation of Waste Heat for Steam-Generating Purposes.	Arthur D. Pratt.

"Phases on Tempering"

(A Paper read before the Steel Treating Research Society at Detroit.)

By Mr. E. W. UPHAM.

In charge of laboratories, Maxwell Motor Company, Inc. December, 1917.

The extremely wide use of hardened and tempered steel has made the general rudimentary principles of treatment rather common every-day knowledge. Somewhere back in the, perhaps now, hazy experience of everyone of us, we can recall stepping into the shop of the cross-roads blacksmith and watching this skilled artisan who has been an important factor in contributing to this general information. With his eye, trained by long practice, to judge a cherry-red, he needed no pyrometer for hardening, neither did he require, in tempering, any temperature indicator other than that provided him by nature; the "temper colors," straw, brown, purple and blue. He realized the importance of obtaining just the right color fully as much, if not more so, than some of our furnace men of to-day know the value of correct pyrometer readings.

The tempering of steel, as one of the operations of heat treating practice, owes its importance to the fact that it is the final treatment performed. Hardening makes the wonderful improvement in properties possible, but it is the tempering that fixes the final condition of the product. Steel as quenched for hardening, does not only possess certain undesirable engineering properties, but it is too hard to be machined.

From the standpoint of the engineer, tempering is important, because, he knows that for any steel, if correctly hardened, a definite amount of tempering will give a definite set of engineering properties; and he relies on these properties being reproduced day after day. To attain this, consequently, the factors controlling this operation must be kept fairly constant to produce a uniform product.

From the standpoint of the production engineer and the shop superintendent, whose interests lie in the machining or working of the product after the heat treating operations, uniformity is likewise demanded. If the steel parts are not held to a fairly close range of hardness, it means loss of time, increased tool cost, in fact a general production loss. There is nothing that will get the heat treating department in disfavor with the rest of the shop as lack of uniformity of product.

Our aim being to produce work of constant and well defined physical properties, several factors tending to help or hinder the attainment of this aim might be mentioned; choice of steel, determination of correct treatment, organization of the hardening department, facilities in the hardening room (including furnaces and means of temperature control), inspection of the product; all of these are important subjects of study, but obviously outside the scope of the present paper. My attempt has been to collect material which, coupled with a few personal observations and conclusions would lead to a better understanding of this work. In assembling the material from the various texts, only accepted theories and well founded explanations have been taken, also, no attempt has been made to go deeply into the theoretical matter, using only that which best suits the explanation of the particular point under discussion.

The tempering of steel as one of the operations of heat treating practice, may be defined as the treatment given after hardening, in obtaining the physical properties desired in the finished product. The effect is usually a "softening" and "toughening" and is obtained by re-heating the steel to a point somewhere below the critical temperature and allow it to cool.

The explanation of the internal changes accompanying this "softening" and "toughening" is very closely related to the internal reactions associated with, and accounting for, the hardening of steel by quenching from above the critical range. Internal changes taking place when steel, on being heated, reaches a definite temperature range, known as its critical range, are evidenced by differences in properties, as for example, it is not attracted by a magnet. These internal changes are designated as allotropic changes—variations in form and ultimate structure rather than in composition. On slow cooling of steel from above the critical range a reversion of the internal reaction takes place, and it would be found to possess its original property of attracting the magnet.

If instead of slow cooling from above the range the steel is cooled rapidly, as by quenching, the tests made will disclose an entirely new set of properties from the original annealed bar. File testing should show a hard metal, where before, it was relatively soft. The microscope would reveal a much more uniform and compact, dense structure. The bar, however, will attract the magnet, showing in this test that the properties of the steel when above the critical range have at least been partially lost and in this particular respect is the same as when annealed. These facts have been explained in that the allotropic or internal changes that take place under slow cooling, have been arrested by quenching, or not allowed to proceed to completion. The result is a condition of unstable equilibrium, considering that of the annealed bar as stable. The quenched piece, possessing greater hardness, tensile strength, and apparently stable, is really in a condition in which there is a tendency to revert to the qualities of the original annealed bar.

The steel as quenched is usually too hard and brittle, also internal strains have been set up which are undesirable. The retardation of the changes has been too great. The desired degree of softness and toughness is obtained by allowing these allotropic changes, arrested by quenching, to proceed further in the direction of the annealed bar, and stopping at the desired point. This is accomplished by re-heating to a temperature below the critical range. It is the control of this re-heating, the determination of the correct temperatures for various steels, and other related conditions, with which we are concerned.

So far, only outward physical manifestations of internal changes have been dealt with. For a more thorough understanding, the changes can be considered not unlike a chemical reaction. Annealed steel is made up of two distinct constituents, iron carbide and iron free from carbon. We say, that above the critical point this iron carbide goes into solution in the free iron. This solid solution of iron carbide and iron is called aus-

tenite. The equation—iron carbide plus free iron gives austenite—shows what takes place above the range. To show the changes that take place on slow cooling, the equation is simply reversed, or,—austenite gives iron carbide and free iron. This reaction requires time to be carried to completion. Slow cooling enables the austenite to change over completely to iron carbide and free iron. Quenching does not allow the necessary time, and the result is only a part of the change as expressed in the reaction.

The equation expresses only the two ends of the reaction, as there are intermediate constituents, changes between austenite, and iron carbide and ferrite which are not included. The complete set of stages recognized are: austenite, martensite, troostite, and sorbite. The relative hardness of these constitutents as given by Mr. H. C. Boynten, and considering pure iron, or ferrite, as one (1), is as follows:

Austenite	104
Martensite	239
Troostite	88
Sorbite	52

Prof. G. B. Upton, in his text "Materials of Construction" states that only two of these four stages can exist as 100 per cent of the total—austenite and sorbite, the two end forms of the series. This is, I believe, contrary to the views held by most of the investigators. Prof. Upton accounts for the range of hardness, tensile strength, etc., between these two end conditions, as due entirely to the varying percentages of the constituents present at any one time. A steel, as quenched, will be largely martensite, but contains, probably, austenite and troostite. Tempering decreases the percentages of austenite and martensite, at the same time increasing the percentage of troostite and introducing sorbite. The varying proportions of the constituents explains very well why such a regular and uniform graduation in properties is obtained with regular increase in tempertographs taken of specimens of a steel, all quenched properly, and then drawn for a fixed time, at regularly increasing temperatures, show this also. There are no abrupt changes in structure until the critical point is reached. If such a series of tempering heats were run on specimens suitable for physical testing, they would show a regular gradation in physical properties. With increase in drawing temperature, there is obtained a decrease in hardness and tensile strength, with a corresponding increase in ductility. This is almost too well known to deserve mention, but the point is, that it is a regular and uniform change in properties.

Thus, the amount of change in a steel desired, by tempering, is regulated almost entirely by control of temperature. The time element is not to be disregarded, but, beyond a certain time, holding longer in the furnace will not decrease the hardness appreciably. Drawing at temperatures where the change corresponding to that temperature does not approach completion, unless very carefully timed, produces a tendency towards non-uniformity of product. From the standpoint of efficiency, in the standardizing of heats for commercial practice, the time element should always be considered and a definite time fixed for each heat. As will be mentioned later, with some classes of work, the tempering must be carefully gauged as to time, to secure the desired uniformity.

Tempering, besides allowing the series of changes from austenite to sorbite to take place, relieves cooling stresses, the two results being accomplished simultaneously. Stresses, due to quenching, are not only caused by the outside trying to contract faster than the inside will allow, but, also, are accounted for by differences in density of the four transformation constituents. Cooling stresses are relieved, slightly, at temperatures as low as the boiling point of water. The relief increases rapidly as the temperature is raised, being fairly rapid at 400 deg. F.

In considering the actual operations in the shop, the question of size of load and methods of handling are of importance. With respect to media in which the work is to be heated: for temperatures up to 500 deg. F. a heavy viscous oil of high flash point is used. From 500 deg. F. to 1000 deg. F. a mixture of low melting salts has been recommended. Above 1000 deg. F. the lead bath or the open furnace is satisfactory. Either may be used for lower temperatures, but there is a tendency for the lead to "stick" and cause trouble.

Steels are usually graded according to their carbon content, and as to special alloying elements present. Carbon steels are divided roughly into three classes: Low carbon, .10 to .25 per cent, medium carbon, .30 to 55 per cent, and high carbon, .60 to 1.50 per cent. Low carbon steels are usually used for carbonized work; medium carbon steels for structural work and machine parts, the high carbon steels, in tools and in special cases where great hardness is desired.

One great effect of carbon in steel is to lessen the rate of the allotropic changes expressed by the reaction; austenite gives iron carbide plus free iron. It is difficult to cool a low carbon steel sufficiently rapidly to retain much martensite; with a high carbon steel a large proportion of martensite is obtained easily. The effect of this on tempering is, that with a quenched low carbon steel, the series of transformations is further along to start with than it is with one of high carbon content. The low carbon steel thus possesses the greater stability, and consequently, there would be less decrease in hardness for a definite temperature draw.

The quenching of case carbonized work, to refine the high carbon case, sets up internal strains that are especially severe, due to the dual nature of the product. The relieving of these strains is the primary object in tempering this class of work, and is accomplished by heating in oil at temperatures varying from 350 deg. F. to 500 deg. F. The hardness of both core and case is somewhat lowered.

With medium carbon steels, the point made with respect to a definite temperature being chosen, and adhered to, in obtaining the physical properties desired, is best applied. In this class of work, if the parts are machined after being heat treated, uniformity of hardness is essential. If water quenched, the range of tempering temperature would be from 900 deg. F. to 1,150 deg. F., or 1,200 deg. F.

The use of the higher carbon steels demands high final hardness readings, and the drawing temperature is correspondingly low The attainment of these higher readings is more difficult of control, and great care should be exercised as to accuracy of temperature and time. It is logical to expect this, as the further the product is away from the sorbite end point, the greater the instability, and hence the more rapid the tempering. Likewise a steel with a higher initial hardness obtained by a more effective quenching agent will temper more rapidly than if the initial hardness were lower, due to slower quenching. Internal quenching strains are high

in the tool steels, due to the higher carbon content, and, as in case carbonized work, part of the work of tempering is relieving the strains.

A great deal has been said and written about the reliability of temper colors. Tables showing the relationship between temper colors and temperature are to be found in handbooks and most of the texts. One of the more recently compiled tables gives one series of temperatures for the corresponding colors, for a time of eight minutes in the furnace, and a series 90 deg. F. to 200 deg. F. lower for a time of one hour. The longer time at the lower temperature is recommended. This table is more nearly correct, as scale colors should be taken as a measure of degree of tempering, and not as a temperature indicator. The only question is, does a certain temper color always indicate the same degree of tempering. Tool hardeners still use the scale colors with very good results. For the best work, and for continually uniform results, accurate temperature control, and regulation of time at exposure to those temperatures, is I believe, the better.

There are several very interesting questions that suggest themselves, and which could be profitably studied. One is, the effect, in general, on tempering, of the various alloying elements. Another is the best methods of testing or inspecting the different classes of work. A third is the relation between the Brinell or scleroscope readings, and the tensile or torsional properties.

I think you will agree with me that tempering presents no especial problems to the man in charge. Improvement in present methods lies largely in standardizing of the treatments and better temperature control. It would be ideal if a quenching medium could be obtained for the hardening operation, that would leave the steel with the austenite to sorbite transformation carried to the precise required point, thus doing away with tempering altogether. However, our present practice of using a too effective quenching medium, and obtaining the desired result by tempering, presents fewer difficulties, since the changes take place at sufficiently low temperatures to admit of far more exact control.

Ingersoll, Ont.

A by-law was passed in Ingersol on January 17th providing special gratuities to The Nicholson File Co., of Port Hope, and The Bissel Mfg. Co. of Elora, to induce them to move their respective plants to Ingersol. The two companies will share the old buildings of The Noxon Co., who have been out of business for some time. The buildings are large and well adapted for the purpose proposed. Local capital is largely interested in bringing the concerns to Ingersol.

The John Morrow Screw & Nut Co. have made large additions to their main factory, and will erect further extensions in the spring. The new buildings are of reinforced concrete and brick construction. The Frid Construction Co. of Hamilton are contractors for this work and also for the repairs and alterations to the old Noxon buildings.

The town of Ingersol is making a very strong bid for new manufacturing concerns, and apparently very successfully, for it is getting to be a very busy little place. There has been considerable talk of a rolling mill, but it is felt that present conditions, both local and general, would hardly warrant the outlay.

Welland, Ont.

The Canadian Steel Foundries Co. have closed down five of their open hearth furnaces, and are only operating one. They have a good stock of ingots on hand for their rolling mill work, which also has been very quiet of late. This firm makes a specialty of steel castings, particularly for car building.

The Page-Hersey Co., manufacturers of pipe, etc., are running fairly steadily, but most of the other steel industries in the city are rather quiet. A number of men have been laid off and others are not working full time.

The War-Weasel, a steel boat, 252 feet long, built by the Shipbuilding Co. here, and launched last fall in the hope of getting it to Montreal before the winter, was delayed by a little trouble with the machinery, and it was found necessary for it to winter here.

The Dillon Crucible Alloy Co. commenced operations in Welland about the beginning of the year. They are at present engaged in the manufacture of Tool Steel. The plant contains a furnace building with one crucible furnace making ingots. A building for forging the ingots, a boiler house, a producer building with two gas producers and a large brick building used for store room and office. The mill buildings were erected by The Standard Steel Construction Co., of Port Robinson.

Brantford, Ont.

Kerr & Goodwins have erected a fine new factory building in Brantford W. The building was intended for American Munition Orders, but as these have been cancelled, it is uncertain what will be done with the building. The firm need a new building for their other work, and they may move into this one.

"Motor Trucks Ltd." had just completed an exceedingly fine new shop when the munitions orders were cancelled. This building is now lying idle until operations can be begun on a permanent line of work.

General Notes, Ontario.

The Iron and Steel industry generally over Southern Ontario is exceedingly quiet. Scarcely any sales are being made and prices have come away down. The attitude on the part of most seems to be "Watchful Waiting," to see what the next man is going to do. Under these conditions it is gratifying to see the Government going ahead with any work that it can contract for. Several good-sized steel highway spans have been let this month. We understand that work on the Welland Canal is to go right ahead. Estimates are being prepared for a new grain elevator at Port Colborne. Large Harbor improvements are being planned for Hamilton. New post offices are expected for Hamilton and London. Large additions have been planned for the Western University, London, and other work is expected before long, so that the smaller manufacturer and the public generally are likely to gain confidence in present conditions and the prices of building material generally.

The open hearth production of the country has increased enormously during the war period, and we need not be surprised if the production must now be reduced. It is to be hoped, however, with the installation of other types of mills, that it will not be long before this extra capacity will be employed on peace lines. Structura lshops are quiet at present, but as bridge and building work has been almost entirely neglected for the last four or five years, it will not be surprising to see these plants soon running full again before very long.

HAMILTON NOTES.

The Steel Co. of Canada has now got both units of their new Coke Ovens in operation. These comprise eighty ovens in all, and the coke is said to be excellent.

Mr. J. L. Campbell, who for long has been superintendent of the Dry Air Plant of The Steel Co. of Canada, passed away at the beginning of this month after an illness of some weeks. Mr. Campbell was a native of Scotland and was trained in the British Navy. His ability as a mechanical engineer was remarkable, and he will be very much missed by the Steel Company. Deepest sympathy is felt for Mrs. Campbell and his two little children.

Mr. rFank E. Breckenridge, Sales Manager for the International Harvester Co., Ltd., passed away on Jan. 17th from complications caused by Spanish influenza. Mr. Breckenridge was, for several years, manager of The McCormack Harvesting Machine Company. For five years he was manager of the Ottawa Branch Company of The International Harvester Company, and has since been in charge of the sales business of the Harvester Company. Mr. Breckenridge leaves a widow, a son who is in the United States Army, and one daughter.

Dominion Foundries & Steel Co. have taken over the buildings lately vacated by The National Abrasive Co. and are moving them to the east end of their Foundry Building.

The Canadian Cartridge Co. have closed down almost completely for a time, until they can get adjusted to normal conditions. They have commenced work on a new line, that of making steel barrels, but this only occupies a small part of the plant.

The International Harvester Co. has officially taken over The Oliver Chilled Plow Works. The two companies adjoin each other on the bay front and for long have been working together, so that the amalgamation will not seriously affect the operation of either company, nor did it come as any great surprise to those interested in the concerns. Mr. Biggart is manager of the Hamilton Branch of the Harvester Co., and he states that a new name will soon be announced for the combined companies.

OBITUARY.

Julius E. Waterous, one of the founders of the Waterous Engine Works at Brantford, Ont., passed away last Saturday at the age of 75. Mr. Waterous was vice-president of the company. He took an active part in the early development of Western Ontario municipalities by the installation of waterworks, which was a specialty of the Waterous company in its earlier career. Mr. Waterous is survived by two sons who arrived home from France only a few days before his death, by a widow and by three brothers, two of whom are connected with the firm in Brantford, and one of whom is a prominent manufacturer in St. Paul.

W. S. Harvey, until recently construction engineer for Leaside Munitions, Ltd., has been appointed engineer of sewers, Toronto Harbor Commission. Under the direction of George Clark, designing engineer to the Commission, Mr. Harvey will prepare plans for the drainage of the Ashbridge's Bay Industrial Area and for the extensions to the city's main sewer outlets beyond the fill along the waterfront. Dr. Harvey spent several years in the sewer section of the Department of Works, Toronto, and was formerly assistant city engineer of Lethbridge, Alta.

Industrial Research vs. Politics

Principal Bruce Taylor of Queen's University opposes Professor Macallum's proposal to Centralize Research Work at Ottawa.

FEARS POLITICAL PATRONAGE.

Speaking on the subject of industrial research at an informal dinner of members of the Canadian Manufacturers' Association at Toronto, Principal Bruce Taylor of Queen's University, Kingston, warned his hearers of the danger of allowing any institution established for the carrying out of research work for industrial purposes coming under the influence of party politics.

The warning was given as apropos to an explanation of the proposal of the Dominion Government to erect and partially support laboratories at Ottawa for this work. As opposed to centralizing research work in any one place, Dr. Taylor favored making use of what facilities have already been developed in the various Universities throughout the country, which might be further developed by the financial backing of the manufacturers themselves.

Inventors Must Have Leisure.

Any plan to establish research laboratories, he said, must be approached in a broad-minded way. The industries fostering and backing such a scheme must realize that they could not always expect results that would have a direct bearing upon their businesses. If the plan was to be a success the experimental work must be done by men with vision, who should be given leisure to dream and potter and trifle: to dally with this scientific clue and that; to go quietly forward with their work unhampered by interruptions.

In support of this Dr. Taylor cited a number of revolutionary inventions which had been the outcome of accident and experiments directed in other directions, displaying a wide knowledge of a number of branches of science.

The logical place to look for such men, he held, was in the Universities, and particularly in Universities where research work was encouraged, and, he added. colleges that did not foster the spirit for research soon lost their virility and usefulness in the community. Universities had two functions: to teach and to carry forward the acquirement of scientific knowledge by experimentation. In the departments of arts and applied sciences, teaching was the main requisite, but in economics and such studies as mining, research work was the chief requirement, and it was through watching scientists at their experiments that the students gained the greatest good.

Praise for Prof. Macallum.

Prof. Macallum, said Dr. Taylor, had proposed to centralize this work in Ottawa, and by subsidies to the University of Toronto, McGill and a French College in Montreal, by means of Government aid. In this he foresaw the chance of the political element entering, and unless great care was taken, getting control. Once one gets into the political swim in Canada, he said, it is extremely difficult to get good work. He admitted that so long as the institute was in the hands of Prof. Macallum and his associates, it would be used for the purposes for which the manufacturers

(Continued on page 39).

INDUSTRIAL RESEARCH VS. POLITICS.

(Continued from page 28.)

would back it, but unless the industrial interests got a firm grip upon it, he feared the control would fall into the hands of political patronage within a few years.

The doctor believed that the industries should range themselves in groups of kindred interests, and take their manufacturing troubles to the universities for solution. At his own college, he explained, many excellent results had been obtained for outside interests, who had paid freely and gratefully for the help they obtained. One large firm, he said, had entered into a business arrangement with his university, whereby it agreed to pay $15,000 a year and not more than $25,000 a year for a period of five years, for a series of experiments in metallurgy. He believed that this plan might be extended to other colleges with profitable results to both parties.

The Electric Furnace Company, Alliance, Ohio, has just closed a contract with the Standard Roller Bearing Company, of Philadelphia for 190 K.W. Continuous, Automatic, Heat-Treating Equipment.

The set consists of one 150 B.W. electric furnace for hardening and one 40 K.W. electric-heated oil drawing bath.

Material, which consists of alloy steel balls and ball races, is automatically handled through the furnaces, quench, and drawing baths, in metal baskets.

GET TO WORK.

This is the advice of Judge Gary, who anticipates no Depression in the Steel Trade.

Building of roadways, reconstruction of railroads throughout the country and all other public improvements contemplated by the government should be begun at once, in the opinion of Judge Elbert H. Gary, chairman of the board of directors of the United States Steel Corporation.

Judge Gary deprecates any suggestion that the country is facing a serious unemployment problem. On the other hand, the country is on sucha prosperous basis, that it does not need any "booming", he says.

"Why should there be any talk about unemployment?" said Judge Gary. "The country never was more in need of its workers than it is now, and it will use all the workers it can get. I don't think there is going to be any permanent or menacing unemployment problem.

"Our country has never been as prosperous as it is now. We have resources of fifteen billion of dollars annually coming out of the ground—more than we ever had before; we have more than sixteen billions of cash in our banks; we are a creditor nation to the extent of fifteen billions or more, and our per capita wealth has jumped up to $56, as compared to $35 before the war. We are in an era of prosperity hitherto undreamed of.

"What we need is simply to get to work and not talk about unemployment. Psychology has a good deal to do with it. Pessimistic talk will do more to bring abount unemployment than it will do to prevent it.

"But there isn't going to be any. Our men who have been fighting abroad will be taken back into industry just about as fast as the yreturn. Of course, there may be a little talk and there about a few not being able to find unemployment, but this will not be serious."

"Do you think the business men of the country should begin doing business on a large scale, so as to tide over any period of depression, as suggested by Secretary of Labor Wilson", Judge Gary was asked.

"We don't need any booming", he replied. "Business will take care of itself. This time of the year is always cleaning up time. It is not necessary for industry to do more than the demand requires. Business is going to boom itself without any help from anybody. There is no doubt about that.

"I do believe that all the public improvements that have to be done should be done now. Men should be at work all this winter on the roads that are to be built in the Southern states. The government should begin the great reconstruction necessary on the railroads of the country, and wherever there is public work to be done it should be done without delay.

"As for the steel industry, we are not thinking of any depression. We had a great many men in the war, and we are taking them back as fast as they return."

Judge Gary's attention was called to a report that Theodore P. Shonts, in order to reduce the number of unemployed in New York, had agreed to employ 1,000 men in cleaning up and painting the subway and elevated stations.

"That is the sort of thing to do", said Judge Gary. "If everybody did what is to be done there wouldn't be enough men to do the work."

EDITORIAL

ELECTRIC SMELTING OF IRON ORES IN CANADA.

In our last number we printed the condensed summary of Dr. Stansfield's recent report on this subject. The detailed information and discussion on which this report was based are contained in a series of chapters or appendices, and while these may be of less interest to the general reader, they cannot fail to be of value to those who are making a closer study of electric smelting, or who are interested in the industrial development of the coastal regions of British Columbia. We print in this issue Appendix I., which deals with the market for iron and steel in British Columbia, and Appendix II., which contains an account of the supplies of iron ores in that province.

CHEMICALLY RE-ACTIVE ALLOYS.

With the end of the war we find a number of markets closed and many industries of recent origin are threatened with extinction. One of these is the production of magnesium, which was undertaken early in the war, the usual supply from Germany having been cut off.

Magnesium was needed in the war chiefly for flashlights and similar pyrotechnic displays, and the ordinary peace consumption for photographic purposes, in Canada, will not require a tithe of the production of this metal that has been attained at Shawinigan Falls. The manufacturers have not been idle, however, and have carried on investigations to find other large-scale uses of this metal; something has been found in regard to its use in alloys and for de-oxidising purposes, but we understand that the factory is temporarily shut down because of the restricted market.

In view of the situation, great interest attaches to some recent discoveries described in this issue. It has been found that alloys of magnesium and lead are peculiarly active in a chemical sense; some of these will absorb oxygen from a moist atmosphere, falling into a powder at the same time, and this alloy can be used for removing oxygen from any gas atmosphere. Other alloys have the power of liberating hydrogen from water, and this property can be used conveniently for the inflation of balloons and for similar purposes. Discoveries of this kind will no doubt be made from time to time, and magnesium may yet find a wide market under peace conditions.

CANADIAN MINING INSTITUTE.

The annual meeting of this Institute was held in Montreal from the 5th to the 7th of March, and will long be remembered by those who were able to attend the meetings and the social functions. The latter were no doubt regarded with special interest by many as being the first in four years at which festivity could be rightly indulged in, and also the last at which the flowing bowl would be available as an aid to conviviality. The meetings for discussion were memorable, because of the very serious consideration that is now being given to turning the activities of war into the pursuits of peace, and in meeting the weighty problems in regard to industry that are presented at this time.

Stated generally, the members of the Institute had their attention directed to accelerating the development of the Mining and Metallurgical industries, in order that these may do their share in carrying the heavy financial burdens that have been laid on Canada in consequence of the war. It was pointed out in the discussions that scientific research must be carried on more thoroughly and on a larger scale than in the past in order to assist these industries; and that, in conjunction with such research, the practical application of new processes must be carried on apace. Canada has a very heavy financial burden to carry, and it is only by improvements in the technical processes, and by their development on an increasing scale, that the burden can be borne.

It was also pointed out that these industries are dependent on the assistance of labour, and that more serious attention would have to be paid to the position of workers in our industrial establishments. Satisfactory progress could not be attained unless an understanding could be reached between labour and management, and unless an equitable policy could be laid down and carried into effect.

Co-operation between nations will also help to solve our common problems; one day of the meeting was entitled the "American Institute Day" and was largely devoted to a consideration of this subject, and to discussions with delegates from the American Institute of Mining and Metallurgical Engineers.

The following are a few of the papers dealing with general topics of this nature:—

Joint discussion with American Institute of Mining Engineers on "Principles of Mine Taxation"; introduced by Mr. R. C. Allen and Mr. T. W. Gibson.

Address on "Industrial Co-operation," by Mr. W. R. Ingalls.

Address on "The Re-Adjustment of Industry with special reference to Mining," by Sir John Willison.

Discussions were held with regard to "A Uniform Mining Law for North America" and "International Co-operation in Mining."

Amongst the technical papers dealing with Metallurgy and Mining may be mentioned "Some Equipment of a Modern Copper Smelter," by Mr. E. J. Carlyle.

"The Application of Pulverized Fuel in Blast Furnaces," by Messrs. E. P. Mathewson and W. L. Witherspoon.

"Electric Smelting with Special Reference to Canadian Conditions," by Mr. Robert M. Keeney.

"Titaniferous Iron Ores," by Dr. Y. L. Goodwin.

"Iron Deposits on the Belcher Islands, Hudson Bay," by Dr. E. S. Moore.

"Internal Corrosion of Wire Cables and a suggested method for its detection," by Mr. W. Fleet Robertson.

"Liquid Fuels: Their Uses, Production, Consumption and Sources in Canada," by Mr. B. F. Haanel.

"Rational Use of Coal for Power and Heat," by Mr. John Blizzard.

Amongst the subjects brought forward for special discussion may be mentioned the proposal by Dr. Stansfield to change the name of the Institute to the "Canadian Institute of Mining and Metallurgy," this change being proposed in recognition of the increasing importance of metallurgy in the Canadian mineral industries. The constitution and activities of the Advisory Council for Scientific and Industrial Research were also described at length by the chairman, Dr. A. B. Macallum and were discussed very fully in a subsequent session. Some of those who took part in the discussion feared that the Research Council were extending their activities too widely and were encroaching on the provinces of other research Institutes such as the Mines Branch at Ottawa, and some of the Universities. Whatever be the result of this enquiry there can be no doubt that scientific research must be encouraged and assisted in every way possible, and that the Advisory Council has made a beginning in this direction.

PROPOSED CHANGE IN THE NAME OF THE CANADIAN MINING INSTITUTE.

Significant of the times is the election of Mr. D. H. McDougall, President of the Nova Scotia Steel & Coal Company to the Presidency of the Canadian Mining Institute, for Mr. McDougall is not only representative of the mining industry by reason of his connection with the coal mines in Cape Breton and the iron ore mines at Wabana, but he is the directing head of a large steel industry.

The recent meeting of the American Institute of Mining Engineers was remarkable for the large number of papers presented dealing with the iron and steel industries, and quite recently that body has changed its name to the "American Institute of Mining and Metallurgy."

A proposal was put forward by Dr. Stansfield—the Secretary of the Iron & Steel Section of the Canadian Mining Institute—at the recent Annual Meeting of the C. M. I. that the Institute should change its name to "The Canadian Institute of Mining & Metallurgy." The proposal is being submitted to a letter ballot of the members. In the discussion which took place upon Dr. Stansfield's motion it was argued by those who were not in favor of changing the old name that the word "mining" was all comprehensive and included all the outgrowths of mining. That may be the case, but the very formation of an Iron & Steel Section of the Institute is in itself recognition of the important place now occupied by the metallurgist. Formerly the metallurgist was called in to the aid of the miner, but today many latent mining propositions await the call of the metallurgist who shall announce the perfection of new processes that will render possible of profitable commercial operation deposits of mineral which are today undeveloped because of their leanness of the presence of objectionable elements.

Dr. Stansfield's proposal connotes a far-sighted apprehension of the part that the metallurgist is about to play as the ally of the mining industry. It is going to be necessary for the Canadian Mining Institute to make it very clear to the metallurgist that he is not only a welcome, but a much desired member of the Institute, otherwise the growing self-consciousness of his increasing usefulness in industry may bring about a cleavage that is the last thing to be desired. Miners and metallurgists must keep together if they are to understand each others' problems and mutually help one another. A striking instance of what may happen if divergent aims are pursued is today afforded by the evidence that is being taken before the Royal Commission coal miners' wages now sitting in England. The identity of the interests of the coal miners and the steel maker is being painfully demonstrated by the statement of responsible directors of steel enterprises that unless the cost of coal can be prevented from reaching an undue figure it will be necessary for the steel manufacturers to move their operations to Sweden or the United States.

It may be quite true from the standpoint of the mining engineer that the word "mining" is all inclusive, a term that Alice in Wonderland would call a "portmanteau word," but the metallurgist may not necessarily feel that way. If his profession is distinctly named in the title of the Canadian Mining Institute there could be no question of the metallurgist's welcome and important status in the Institute.

The intimate manner in which the miner and the metallurgist are connected is well illustrated in the composition of the membership of the Mining Society of Nova Scotia, which is now an integral part of the Canadian Mining Institute. The activities of the coal miner, the iron ore miner, the quarryman, and the steel-maker are so inextricably connected that one would imagine they had a great deal in common. As a matter of fact they have in actual practice very little in common, and know surprisingly little about each others' daily business—too little indeed. Nothing has brought these men together so felicitously and brought them to recognise each others' inter-dependence and connection as the Annual Meetings of the Mining Society and exchange visits between collieries and steel-works. It has for a long time been apparent in Nova Scotia that the Mining Society was partly a mining and partly a metallurgical association, and there is no doubt that a proposal to recognize this fact in the name of the larger body, the C. M. I., will be very well received in Nova Scotia—and after all it is the natural outcome of the formation of the Iron & Steel Section of the Institute.

Perhaps there is not much in a name, nor will the changing of the title of the C.M.I. effect any radical change in the development of the Institute or the feelings of its members one to the other, but what is pleasing, and significant of the virility of the Institute, is the recognition through Dr. Stansfield's motion of the value to its councils of the metallurgist, and the desire thereby expressed that we should retain and strengthen this outgrowth of the miner's art, even if it involves a change in name.

The term metallurgist is not usually considered to include manufacturing processes. It is more properly and particularly applied to those processes of refinement of metals, and smelting down of ores which are usually included in the activities of a mining company. In the nicety and perfection of these processes was the genesis of many successful mining operations, a point that it is not necessary to labor.

It would be a graceful recognition of the debt the mining industry owes to the metallurgist—and that word, be it remarked, is also fairly comprehensive—if Dr. Stansfield's proposal were adopted, and, in the opinion of many, it would strengthen the hold of the Canadian Mining Institute upon the complex and varied industry it claims, and rightly claims, to represent.

FURNACE REFRACTORIES.

In another portion of this issue we print Messrs. McDowell and Howe's report of their experiments upon basic Refractories for the Open Hearth, and we congratulate the authors upon their efforts to establish reliable data on this important subject. When it became no longer possible to secure Austrian and Grecian magnesite, attention was automatically turned to the possibility of obtaining supplies from the United States and Canada. The largest American deposits are those of California and development of these has been taking place for some years, but the product was largely absorbed by paper mills, prior to the war. In Canada three companies have been operating in Argenteuil County, Quebec, and like the American, until recently the product was mostly used for other than refractory purposes. Of all the basic and neutral refractories those containing magnesia are the most important. Ranking as the most widely used they also claim the greatest possibilities as regards varied application. Papers such as the one now under discussion are of the utmost value and importance for a number of causes may arise bringing in their train endless troubles and disappointments to the user of refractory materials. At relatively low temperatures some of these products will spall; they will crack when the metallic bath comes into contact with them, or crumble away under changes of temperature, whilst others are satisfactory under such tests and will withstand high temperatures and active slags. This uncertain behaviour is due partly to differences in chemical composition; partly to varying structure of the raw materials, and partly to changes in methods of preparation. The use of magnesia-bearing minerals is not new, for they have long been used both in the raw and calcined state, as fettling for furnaces. Styrian magnesite has been mixed with clay, and from this product bricks have been formed, burned at a high temperature and then used in iron glass, and other industries. A favorite lining for basic furnaces in Styria was made from serpentine containing 44 per cent of silica, 43 per cent magnesia, and 11 per cent of water, and a magnesia brick has long been used in the old type of puddling furnace. In estimating the value of magnesia products one has to base all calculations upon the infusibility and resistance to chemical action of pure magnesia. Its invariable tendency to combine with acid materials, a tendency which assumes a greater activity at high temperatures, must, however, be borne in mind. Various methods of preparing magnesite for use in basic furnaces have been employed and are being tried out. We have succeeded in making quite satisfactory basic furnace bottoms with a Canadian magnesite of the following composition:—

Silica	6.15
Alumina	8.10
Oxide of iron	4.50
Lime	17.81
Magnesia	62.84
Loss on ignition	0.60
	100.00

At first it was found almost impossible to secure any sintering with this material, and the magnesite remained in divided particles, but by adding about 15 per cent of basic open hearth slag, finely pulverized and well mixed with the magnesite, the trouble was overcome. In using a magnesite deficient in natural iron content it is better to build up the hearth by layers of not more than one inch in thickness, and to allow each layer to become thoroughly sintered before adding the next. The same material was used to repair a bottom after each heat, but dolomite was used to make good the erosion and cutting around the banks and slag lime. The authors of this eminently useful and practical paper have clearly indicated what characteristics are desirable for a basic refractory, but have devoted most of their attention to the American product, whilst we in Canada are called upon to devote our time and attention to the development of our own resources. It has been demonstrated that local deposits are suitable for certain purposes without an addition, and satisfactory methods are being evolved by means of which other desirable elements—such as iron—can be added. We are satisfied that, by a judicious handling of the proposition, all the demands of basic steel manufacturers in Canada can be met by the local supplies of magnesite. This in itself is only one section of the potential market, but if properly handled it will prove of considerable importance. The whole question of refractory materials presents a wide field for investigation for, besides magnesite, there are found in Canada steatite, chromite, bauxite, and other of the basic or neutral refractory materials. As acid refractories we have the silicious materials which depend for their value upon the infusibility of pure silica. These may be used in either of four different forms: natural rock; prepared mass; burned brick; or electrically fused quartz, and when it comes to building or lining structures that have to withstand high temperatures there is invariably one way, and one way only to obtain the best results. Scientific investigation can be of the utmost assistance to commercial development, and it is essential that the two progress together in the solution of industrial problems. The bricks, slabs, sections, and unmoulded refractories of to-day are infinitely better than was the case ten, twenty, or thirty years ago, but there are still uninvestigated phenomena awaiting the time and attention of the research scientist. Take the products of silica alone and realize the number of factors that demand attention. Silica exists in five allotropic forms—quartz, cristobalite, tridymite, chalcedony, and glass, but it would be difficult to name the number of physical characteristics imparted to silica products, by selection of raw material, by mixing, by burning, etc., etc.

Ask those in authority why they cannot secure a greater life from open-hearth furnace roofs, and their answers will be approximately these: progressive decrepitation under the action of heat; failure through melting; failure through heavy spalling, or because of the inferior quality of the bricks. Whatever the cause, the final investigation of the problem of silica refractories has yet to be made. Beyond these there are factors which are beyond the makers' control; the designing engineer may have the profile of his furnace incorrect; the burners may not be in the most desirable position; the heating of a furnace may have been too sudden, the gas may be badly regulated, or trouble may arise through too long intervals between reversals of the flame. In whatever laboratory experimental work may be done, an approximation of actual working conditions should be aimed at, and, when such factors as fusibility, compressive strength at high temperature, permeability, expansion, dilation, and compressive strength at ordinary temperatures, have been fully investigated, we shall know more concerning silica refractories than we do at present. The problem is dual in nature; the first part relates to the materials used and the methods of manufacture, and the second to the most advantageous manner of utilizing the manufactured article.

Electric Smelting of Iron Ores in British Columbia

By ALFRED STANSFIELD.
British Columbia Department of Mines,
Bulletin No. 2, 1919.

(Continued from February Number).

APPENDIX I.

Markets for Iron and Steel.

This subject should be given the first consideration, as we require to know what amounts and varieties of iron and steel can be disposed of, and at what prices they can be sold. This information will determine the scale of the operations, and will have a bearing on most of the other lines of inquiry. There may be available an export as well as a local market, but I have limited my inquiries almost entirely to the market in British Columbia.

Members of the Metal Trades Association, whom I met in Vancouver, and Mr. Giles, of the Vancouver Engineering Works, expressed the opinion that, if pig-iron could be produced locally at a reasonable figure, there would be a market for about 50 tons daily. As iron was selling at $60 to $70 a ton, it appeared that a local iron selling at from $30 to $40 a ton would be able to secure a large market. Mr. Hart, the secretary of the association, tried to obtain from the members individual statements of the amount, quality, and price of their purchases of pig-iron, to form a basis for my investigation; but I have not received any information from him.

Messrs. Evans, Coleman & Evans, of Vancouver, informed me that the consumption of pig-iron in that district was only 3,000 to 4,000 tons per annum, corresponding to 10 tons daily. In view, however, of the fact that Vancouver iron-foundries are now using about 40 per cent. of new pig-iron and 60 per cent. of scrap-iron, whereas normally these figures would be reversed, it appears that the ordinary demand, with iron at a more reasonable price, would be about 20 tons daily.

Mr. Nichol Thompson estimates the market for foundry iron in British Columbia as 10,000 tons per annum, which would be 30 tons per day; and states that in 1912 British Columbia imported over 7,000 tons of pig-iron. These figures are said to be quite apart from the new ship-building industry, which should lead to an expansion in the market for both iron and steel.

In undertaking the smelting of iron ore, it must be remembered that the amount of pig-iron used in foundries for iron castings is far less than the amount which is converted into steel, and therefore, as the market for foundry iron is somewhat limited, we may suitably enlarge the scale of operations by producing some pig-iron for steel-making. An idea of the relative consumption of the several varieties of iron and steel can be gained from the following table, which was sent to me by Mr. John McLeish, of Ottawa, in reply to an inquiry in regard to the market in British Columbia:—

Imports of Iron and Steel Goods from Foreign Countries through Ports in British Columbia and Alberta during Twelve Months ending March 31st, 1915.

Product.	Quantity, Short Tons.	Value.
Pig-iron	2,341.0	$ 27,838
Ingots, billets and forgings	67.7	4,564
Scrap	262.0	2,700
Cast-iron pipe	1,411.5	41,319
Steel rails and connections	14,993.5	379,134
Angles, bars, plates, etc.	15,394.5	552,939
Tin-plate	8,217.5	621,051
Wire rods, wire, and wire nails	5,404.4	378,076
Nails, rivets and nuts	402.0	22,712
Chain	205.4	19,385
Car-wheels, anchors and other manufactures	282.5	17,085
	48,982.0	$2,066,776
Other iron and steel products and manufactures, valued at	....	4,391,955
Total value	....	$6,458,731

The amount of steel produced from a ton of pig-iron depends to some extent upon the process employed; thus the Bessemer process yields something less than 1 ton of steel, while the open-hearth process or the electric steel-furnace, using a mixture of pig-iron and steel scrap, may produce more than 2 tons of steel per ton of pig-iron. Without attempting to analyze the steel market in any detail, it seems probable that some 25 or 30 tons daily of pig-iron could be converted into steel and disposed of in the form of small rods and rolled sections, steel castings, and other steel products.

The price of pig-iron in British Columbia will, in general, depend on the price in the Eastern States, together with the freight and the import duty. The following table, supplied to me by Mr. W. G. Dauncey, shows the cost of pig-iron during the last ten years per long ton of 2,240 lb.—

Cost of Pig Iron During Recent Years.

Year.	No. 1 Foundry, Philadelphia.	Bessemer, Pittsburgh.	Foundry, Cincinnati.	Foundry, Chicago.	Low Sulphur, Chicago.
1908	$17.33	$17.03	$15.83	$17.25	$20.25
1909	17.30	17.46	16.05	17.48	19.50
1910	16.87	17.16	14.85	17.10	18.69
1911	15.20	15.74	13.62	15.19	17.00
1912	15.98	15.04	14.96	15.77	16.75
1913	16.56	17.16	14.98	16.39	16.55
1914	14.59	14.90	13.41	14.15	15.61
1915	15.25	15.85	13.49	14.46	16.31
1916	21.20	24.00	18.74	20.67	21.00
1917	40.68	43.62	38.01	41.06	44.25

During 1917 the prices became very erratic and shot up to enormous figures. The United States Government consequently regulated the price of pig-iron and that of the ore and fuel needed for its production. From September, 1917, to September, 1918, a standard price of $33 was fixed for pig-iron at Birmingham; other varieties of iron ruling at somewhat higher figures. Thus No. 2 Philadelphia, has been sold at $34.40; Bessemer, Pittsburgh, at $36.60; and Lake Superior (charcoal), Chicago, at $37.85. In October, 1918, these prices have been raised in most cases about $1.

Before the war, with Eastern prices about $15 per long ton, the price in British Columbia would be between $25 and $30. Mr. Nichol Thompson states that

during his thirty years' experience he has only once seen pig-iron under $22 per ton, and that the price has ranged from $22.50 to $32.50 per short ton; that is, $25.20 to $36.40 per long ton. It is frequently mentioned that Chinese pig-iron has been imported at a price of $19.50. This iron was brought in as ballast, it was ungraded, and I understand that it was of very poor quality and that some of the buyers have been unable to use it. It is possible, also, though I cannot now check this point, that the price was for a short ton, corresponding to $21.84 per long ton. The only importation from China since 1913 was in the year 1916-17, amounting to 400 tons; and in view of the requirements of Japan, it seems unlikely that any Chinese iron will come to British Columbia in the near future.

The present price for pig-iron in the Eastern States is $33 per ton; adding to that a freight of $15 and a duty of $5 would make $53 in British Columbia. As, however, the exportation of iron from the United States has been prohibited, the actual price is higher than this, and has ranged from about $60 to $80 per long ton.

While it is impossible to predict the course of prices after the war, it seems likely, in view of the high cost of living and the increasing powers of the working-classes, that the price of labor, and consequently the price of manufactured products, will not return again in the near future to the pre-war figures. If we may assume that Eastern prices of pig-iron will not fall below $20, it will follow that the normal price of pig-iron in British Columbia will not fall below $35, or at the lowest price $30, for a period of several years.

The freight from Eastern iron centres to Vancouver has been about $10 per ton, but is higher at present. In August the rate from Hamilton to Vancouver on iron and steel was 60 cents per 100 lb., or $13.44 per long ton. Freight rates from American furnaces cannot be obtained at present, as the export of pig-iron is prohibited. The duty on pig-iron from the States is $2.80 per long ton plus 7½ per cent. ad valorem which at present prices comes to about $2.25 per long ton, or a total charge of about $5 per long ton.

The B. L. Thane Corporation place the price of pig-iron in California as $25 per ton before the war, being the Eastern price of $15 plus $10 freight. At present they take the Government price of $33 at Birmingham plus $10 freight, or $43 a ton. They assume that after the war the price will be about $28 per ton, or an advance of $3 over pre-war prices. They consider that the market for iron and steel on the Coast is at least 600,000 or 700,000 tons a year, and probably 1,000,000 tons.

British Columbia is very well situated for shipping manufactured products to Japan and the East generally, and if pig-iron and steel could be produced cheaply we might be able to command a considerable export market. Electric-furnace iron will, however, be too costly to compete with blast-furnace iron, even when the latter is brought long distances by water. Wherever there is an iron industry there will be a moderate demand for high-grade pig-iron, and an electric-smelting industry in British Columbia will probably be able to develop a fall market for this product throughout the East.

Mr. Dauncey's table of iron prices shows that in normal times there is a difference of $3 or $4 between the price of different classes of pig-iron. In August, 1913, the prices of Bessemer and foundry irons varied from $50 to $55, including freight, at most points in Eastern Canada, and electric-furnace pig-iron was sold at Eastern Canadian furnaces at a standard price of $58.

With regard to the possibility that a blast-furnace plant may be established in the State of Washington, and that it may capture the market for iron in British Columbia, I may state that the B. L. Thane Company estimate the cost, under 1918 conditions, of making iron in the State of Washington at $22, $26, and $30, on three assumptions with regard to the cost of supplies. Taking the middle estimate, $26, and adding the freight, say $2, and the Canadian duty of $4.75, would raise the cost of iron delivered in British Columbia to about $33; a figure which is about the same as the cost of making electric-furnace iron with power at $15. The bounty offered by the British Columbia Government would, apparently, turn the scale in the favor of the electric product. After the war the duty of 7½ per cent. ad valorem will no doubt be withdrawn, and in general we must expect that a blast-furnace plant on the Pacific coast would be able to take a part at least of the market in British Columbia for the cheaper grades of iron, but, with the help of the Canadian duty and the Provincial bounty, an electric-smelting plant in British Columbia should be able to retain the local market for the higher grades of iron.

Information with regard to the price of pig-iron in British Columbia differs considerably: Mr. Watson Griffin, Superintendent of the Commercial Intelligence Branch of the Department of Trade and Commerce, Ottawa, on September 4th quotes "one of the largest ship-building companies on the Pacific coast" as saying: "We beg to advise that we have been paying for pig-iron during the last year between $65 and $75 per ton of 2,000 lb." This would be between $73 and $84 per long ton. On October 19th he quotes the Industrial Commissioner of Vancouver as saying: "The prevailing prices during the past two years have been from $45 to $69 per ton, which is the price at the present time for Hamilton pig-iron delivered at Vancouver. The present quantities required in British Columbia will run approximately from 7,000 to 10,000 tons per year. I have been unable to get an estimate of the quantities that will be required in the next two or three years." Mr. Griffin subsequently ascertained for me that these lower prices referred to the long ton.

APPENDIX II.

Supplies of Iron Ore.

There are, in easily accessible parts of British Columbia, a number of deposits of magnetite ore that appear to be suitable for electric smelting. In the absence of a regular demand for such ores, scarcely any of these deposits have been opened up, and it is impossible to state with any degree of accuracy the amount and analysis of the ore or the cost of mining it.

In view of these circumstances, it was arranged that Mr. Wm. Fleet Robertson and Mr. Brewer would furnish me with the best information at their disposal with respect to the ore bodies, and that I would use this information as the basis of my report; it being understood that I am not accepting any responsibility with regard to the accuracy of such information. I have, however, been able to obtain some independent data, which agree in general with those furnished by the Government officials.

Amount of Ore needed.—As the ore may be assumed

to contain, on an average, not much more than 50 per cent. of iron, about 2 tons of ore will be needed for each ton of pig-iron. Thus for a production of 50 tons of pig-iron daily we must have 100 tons of ore, or 35,000 tons per annum. A supply of 50,000 tons per annum for ten years, or 500,000 tons in all, would appear adequate for the present inquiry.

Location of Deposits.—It is assumed, for the purpose of this report, that an electric-smelting plant would be erected at some point on tide-water within a reasonable distance of Vancouver; its location being determined, among other considerations, by the need of obtaining electric power from the lines of an electric power company. It follows from this that the ore-deposits selected for consideration should be those that are situated on tide-water within easy transportation distance by water from Vancouver.

Available Ore-deposits.—A statement compiled by Mr. Wm. Brewer, and approved by Mr. Wm. Fleet Robertson, will be found in this Appendix. It contains a list of the more important deposits of iron ore that are likely to prove suitable for supplying an electric smelter. The statement shows the distance of each deposit from the tide-water, the estimated amount of ore, and the percentage of iron, sulphur, phosphorus, and insoluble in samples taken from each deposit. It appears the statement that there are several conveniently situated deposits, any one of which may be expected to furnish the required amount of ore. There can be little doubt that if two or three of these were opened up a sufficient supply of ore of reasonable richness and purity would be obtained.

Natures of the Ores.—The ores available are almost all magnetites. Such ores are less easily smelted in blast-furnaces than haematite ores, and it is usual, therefore, to provide for an admixture of haematite when smelting magnetities. It is quite likely that, in electric furnaces, haematite ores would smelt more readily than magnetities, although, as very little preliminary reduction of the ore can be effected in such furnaces, the difference is likely to be less marked. It happens, however, that the commercial smelting of iron ores in electric furnaces has nearly always been carried out with magnetites, either alone or with small additions of haematites, so that we know definitely that magnetite ores are suitable for electric smelting.

The ores available, while adequate in amount and convenient in location, are neither as rich in iron nor as free from impurities as the magnetite ores that have been smelted in electric furnaces in Sweden or California. Many of the Swedish ores contain as much as 60 per cent. of iron, and the Californian ore has nearly 70 per cent. of iron, but the ores available in British Columbia cannot be assumed to average more than 50 or 55 per cent. The published analyses or ore samples, including those contained in this Appendix, frequently show as much as 60 per cent. of iron, but Mr. Fleet Robertson is satisfied that, if the ore-bodies are mined in a wholesale way, and without any attempt to pick the best ore, it will not be safe to count on an average richness of more than 50 to 55 per cent. of iron. He informs me, however, that the gangue accompanying the ore is limey in character, and that by taking a suitable proportion of the rock with the ore a smelting mixture can be obtained having enough limestone to be self-fluxing, and carrying at least 50 per cent. of iron. It may be pointed out that for making a foundry iron silica is essential in the smelting mixture; thus, at Heroult, the ore was so pure that it was necessary to add quartz. Moreover, a certain amount of slag must be produced to flux off the sulphur which is present in the ore. Greater economy would undoubtedly result, however, if the smelting mixture could be made to contain as much as 60 per cent of iron.

The Swedish ores are exceptionally pure, containing usually from 0.01 to 0.02 per cent. each of phosphorus and sulphur. The available ores in British Columbia are reasonably free from phorphorus, containing as a rule less than 0.03 per cent. of this element, so that Bessemer iron can be made from them. The sulphur is, however, somewhat higher than is desirable. Some of the ores, notably those from Texada Island, contain some tenths of a per cent. up to 1 per cent. of sulphur, but it seems probable that a supply could be obtained that would not contain more than about 0.1 per cent. of that element. This amount of sulphur will not interfere at all seriously in the production of a good foundry iron, but it will render the ore less valuable for making special grades of "charcoal" iron.

From among the various deposits three groups have been selected—namely, those on Texada island, Nos. 1, 2, and 3; those on Redonda island, Nos. 9 and 10; and those at Nootka sound, Nos. 13 and 14. Mr. Brewer has prepared estimates of the cost of mining the ore from each of these deposits and transporting it to a port on the east coast of Vancouver island, or in the neighborhood of Vancouver. He finds that, including a royalty of 50 cents per ton to the owners and miner of the ore, the cost of ore delivered at the smelter will be about $4 per net ton. As about 2 net tons of ore will be needed for each long ton of pig-iron, the cost of the ore will be about $8 per ton of pig. This is a very serious item of cost, and is far higher than the usual cost of ore at Eastern furnaces. In view, however, of the nature of the ore-bodies, the moderate scale of mining and transportation, and the high cost of all operations on the Coast, it does not appear that any material reduction can be expected, at any rate during the next few years. If the ore were being mined for sale, there should be added the Provincial Government tax of 37½ cents per ton; but in the present case it appears reasonable to count this as a deduction from the bonus of $3 per ton paid by the Government for pig-iron produced locally from British Columbia ores.

Iron Ores of British Columbia.

(Data compiled by Wm. M. Brewer, Resident Engineer, Western Mineral Survey District, Nanaimo, B.C., June 8th, 1918.)

The accompanying tables show:—

First: The estimated cost for mining and transporting iron ore mined from the most accessible properties to any established port on the east coast of Vancouver Island or at Vancouver.

Second: The names and locations of the various properties, with the distance from deep water, also the available tonnage, very roughly estimated, in three classificatiins — "actual," "probable," and "possible" ore. Owing to the lack of development work it is impossible to measure the ore reserves with any degree of accuracy. Where a star is placed beside the name of a property it indicates that it is impossible to make any estimate of available tonnage at present.

Third: The nature of the ore and assay results obtained from the samples collected at various times, together with the names of the collectors.

Estimated Cost of Mining and Transporting Iron Ores.

Three deposits only have been considered in the following table, viz.: Those located on Texada and Redonda islands and at Nootka sound. These are selected because, owing to their accessibility, together with the quality and quantity of the ore, they would be the natural choice as the first sources of supply.

Texada Island, Nos. 1, 2, 3—

Estimated cost of 3-drill plant	$ 5,000
Estimated cost of transportation	10,000
Estimated cost of bunkers & docks	10,000
Total estimated cost of installation	$25,000

Estimated Cost of Mining and Transportation per Ton of 2,000 Lb. (Figuring 50,000 Tons per Annum.)

Interest and depreciation on installation at 20 per cent.	$0.10
Estimated cost of mining	2.00
Estimated cost of tramming	.25
Estimated cost of freight	1.00
Estimated cost of unloading	.25
	$3.60
Royalty to owner per ton	.50
Cost of ore at smelting plant	$4.10

Redonda Island, Nos. 9 and 10—

Estimated cost of 3-drill plant	$ 5,000
Estimated cost of bunkers and docks	10,000
No transportation required.	
Total estimated cost of installation	$15,000

Estimated Cost of Mining and Transportation per Ton of 2,000 Lb. (Figuring 50,000 Tons per Annum.)

Interest and depreciation in installation at 20 per cent	$0.10
Estimated cost of mining	2.00
Estimated cost of loading	.15
Estimated cost of freight	1.00
Estimated cost of unloading	.25
	$3.46
Royalty to owner per ton	.50
Cost of ore at smelting plant	$3.96

Nootka Sound, Nos. 13 and 14—

Estimated cost of 3-drill plant	$ 5,000
Estimated cost of tram-line	10,000
Estimated cost of bunkers and docks	10,000
Total	$25,000

Estimated Cost of Mining and Transportation per Ton of 2,000 Lb. (Figuring 50,000 Tons per Annum.)

Interest and depreciation on installation at 20 per cent	$0.10
Estimated cost of mining by large quarry	1.50
Estimated cost of tramming	.25
Estimated cost of freight	1.50
Estimated cost of unloading	.25
	$3.60
Royalty to owner per ton	.50
Total	$4.10

Note.—The estimated cost for freight is based on transportation by scows or barges from the Texada Island and Redonda Island deposits, and by freight-steamers properly equipped for hauling iron ore from the Nootka Sound deposits in cargoes of 500 tons and upwards.

(After consultation with Mr. R. H. Stewart, Mr. Brewer has decided to increase his estimate for a 3-drill plant to $12,000 in view of present conditions. This change will only represent a few cents per ton added to the estimated cost of mining.)

Names and Locations of Properties.

No.	Name of Property.	Location.	Approximate Distance from Deep Water.
1	Prescott	Texada island	1,000 feet.
2	Paxton	Texada island	About one mile.
3	Lake	Texada island	About 1½ miles.
4	Iron River*	Branch of Quinsam river, east coast of V.I.	13 miles.
5	Quinsam Lake Iron Syndicate	Upper Quinsam lake, near east coast of V.I.	About 25 miles.
6	Iron Crown*	Nimpkish (Klaanch) river, near Nimpkish lake, V.I.	About 21 miles.
7	Kitchener*	Wigwam bay, Seymour inlet, Queen Charlotte sound	Close.
8	Alexander*	South shore of Seymour inlet, Queen Charlotte sound.	Close.
9	Elsie*	West Redonda island	On shore.
10	Black Warrior*	West Redonda island	On shore.
11	Cumshewa*	Louise island of Queen Charlotte group	On shore.
12	Eagle and Sunrise	West arm of Quatsino sound, V.I.	
13	Glengarry and Stormont	Head bay, Nootka sound, west coast of V.I.	1¼ miles.
14	Fido	Head bay, Nootka sound, west coast of V.I.	1½ miles.
15	Western Steel*	Sechart, Barkley sound, west coast of V.I.	2 miles.
16	Bald Eagle*	Sechart, Barkley sound, west coast of V.I.	2 miles.
17	Crown Prince	Sechart, Barkley sound, west coast of V.I.	2 miles.
18	Sarita	Sarita river, Barkley sound, west coast of V.I.	1½ miles.
19	Clifton	Tzartoos island, Barkley sound, west coast of V.I.	½ mile.
20	Black Prince	Uchucklesit harbour, west coast of V.I.	½ mile.
21	Henderson Lake	Henderson lake, west coast of V.I.	1,000 feet to lake, 12 miles to deep-sea harbour.
22	Defiance*	Handy creek, Alberni canal, V.I.	1 mile.
23	Rose*	Gordon River, near Port Renfrew, V.I.	5 miles.
24	Sirdar	Gordon River, near Port Renfrew, V.I.	9 miles.
25	Conqueror	Bugaboo creek, tributary of Gordon river, near Port Renfrew, west coast of V.I.	9 miles.
26	Baden Powell and Little Bobs	Gordon valley, west coast of V.I.	7 miles.
27	Prince's Iron*	West arm, Quatsino sound, west coast of V.I.	2 miles.
28	Britton and Monarch	Chromium creek, tributary of Klinaklina river, flowing into Knight inlet, mainland coast	
29	North Pacific Iron Mines	Limonite (Summit) creek, tributary of Zymoetz river, Skeena Mining Division	60 miles from G.T.P. Ry.
30	Glen Iron Mine	Cherry bluff, Kamloops lake, 13 miles west of Kamloops	Adjoins C.P.R. track.
31	Ralph*	East Sooke, V.I.	1 mile.
32	Darby and Joan*	Alberni canal	½ mile.
33	Iron Mountain and Chieftain	Kennedy lake, V.I.	18 miles.

Quantity Roughly Estimated.

No.	Actual Ore. Tons.	Probable Ore. Tons.	Possible Ore. Tons.	Total. Ore. Tons.	Remarks
1	.....	1,366,400	993,000	2,360,000	McConnell's estimate.
2	.....	1,607,200	......	1,607,200	McConnell's estimate.
3	...	504,000	....	504,000	McConnell's estimate.
5	......	......	5,000,000	5,000,000	Brewer's estimate.
7	......	......	......	.....	See report by George Clothier, M.E., Minister of Mines' Report, 1917, p. 64.
8	......	......	......		
13	250,000	250,000	750,000	1,250,000	Brewer's estimate.
14	......	50,000	200,000	250,000	Brewer's estimate.
17	75,000	......	200,000	275,000	Brewer's estimate.
18	......	30,000	25,000	55,000	Provincial Mineralogist's estimate.
19	3,000	5,000	25,000	33,000	Brewer's estimate.
20	15,000	......	15,000	30,000	Brewer's estimate.
21	20,000	......	280,000	300,000	Brewers' estimate.
24	94,000	......	47,000	141,000	Brewer's estimate.
25	16,000	230,000	120,000	366,000	Brewer's estimate.
26	......	500,000	250,000	750,000	Brewer's estimate.
29	......	562,500	1,135,000	1,697,500	McKenzie's estimate. (See Lindeman's report in Vol. I., p. 30, "Iron Ore Occurrences in Canada," Can. Dept. of Mines, 1917.)
Totals	473,000	5,105,100	9,040,800	14,618,700	

Nature of Ore and Assay Results.

No. Nature.	Iron. P.C.	Sulphur. P.C.	Phosphorus. P.C.	Insoluble. P.C.	Remarks.
1—Magnetite "lime gangue"	66.0	Nil	Trace	3.3	Average across face of adit 430 feet below the highest outcrop. Brewer's sample.
	68.2	Trace	.....	....	Copper, nil; manganese, 0.08%; McConnell's sample.
	64.3	0.303	.....	....	Copper, 0.14; McConnell's sample.
	55.2	0.266	.....	....	Copper, 0.14; McConnell's sample.
	62.57	0.403	0.024	6.46	Lindeman's sampling.
	58.76	0.113	0.011	12.0	Lindeman's sampling.
	63.27	0.347	0.013	4.37	Copper, 0.08%; Lindeman's sampling.
	69.85	0.6	Trace	2.75	Geol. Survey of Canada, 1886, p. 37B.
	67.91	.....	Trace	2.96	Fulmer, Geol. Survey of Washington.
	65.71	.....	0.013	....	Tenth Census, U.S. Represented lot of 600 tons smelted at Irondale by Puget Sound Iron Co.
2—Magnetite "lime gangue"	59.4	1.07	.....	....	Copper, 0.3%; McConnell's sample.
	64.48	1.866	0.005	4.47	Copper, 0.22%; magnesia, 1.13%; lime, 1.32%; alumina, 0.66%; Lindeman's sample.
3—Magnetite "lime gangue"	58.0	1.6	Trace	0.5	Brewer's grab sample from dump.
	57.5	0.046	.....	....	Copper, trace; McConnell's sample.
	69.4	0.01	.....	....	
	59.57	0.137	8.33	8.33	Copper, 0.08%; alumina, 1.17%; lime, 3.82%; magnesia, 1.05; % Lindeman's sample.
4 Magnetite	56.45	0.53	0.03	7.0	Copper, 0.7%; alumina, 2.07%; lime, 3.77%; magnesia, 1.25%; Lindeman's sample. Property owned by Canadian Collieries (Dunsmuir), Ltd.
	59.77	0.533	0.024	11.0	Lindeman's sample.
5—Magnetite, lime and garnetite gangue	58.6	Trace	Trace	9.3	Brewer's sample from dump.
6—Magnetite	64.23	0.233	0.010	4.12	Lindeman's sample.
	63.89	0.017	0.021	5.30	Copper, trace; alumina, 1.74%; lime, 0.80%; magnesia, 1.86%; Lindeman's sample.
7—Magnetite	65.5	0.5	.....	4.6	Clothier's sample, Minister of Mines' Report, 1917.
8—Magnetite	60.0	0.30	0.11	6.37	Alumina, 7.6%; lime, 1.8%; combined water, 0.11%; magnesia, trace; Clothier's sample.
9 Magnetite	71.28	.....	.....	0.89	Lindeman, Vol. II., "Iron Ore Occurrences in Canada," Can. Dept. of Mines, 1917.
10 Magnetite	.....	.....	.....	....	No samples reported.
11 Magnetite	68.0	0.01	0.008	1.2	Lime, 1.0%; Minister of Mines' Report, 1911, p. 77, and Lindeman's in "Iron Ore Occurrences in Canada," Can. Dept. of Mines, 1917, p. 18.
12 Bog	54.46	0.15	0.038	2.32	Lindeman's sampling.
	56.97	0.447	0.038	1.40	Lindeman's sampling.
13—Magnetite limestone gangue	56.08	0.1	Trace	1.6	Brewer's sample.
	66.17	0.017	0.016	6.1	Lindeman's sample.
14 Magnetite	.....	.....	.....	....	No samples reported.
15—Magnetite limestone gangue	59.69	0.04	0.016	12.76	Lindeman's sample.

16—Magnetite limestone gangue	59.37	0.716	0.006	13.36	Lindeman's sample.
	60.7	Trace	Trace	13.6	Brewer's sample.
17—Magnetite limestone gangue	54.4	1.4	Nil	21.2	Brewer's sample.
	55.6	0.4	Trace	17.6	Brewer's sample.
	48.4	0.7	Trace	....	Carmichael's sample.
	48.06	0.623	0.006	23.22	Lindeman's sample.
18—Magnetite limestone gangue	63.8	0.55	Trace	4.2	Brewer's sample.
	63.7	0.3	Trace	3.85	Carmichael's sample.
	60.89	0.76	0.004	3.81	Lindeman's sample.
19—Magnetite	56.2	1.3	Nil	17.0	Brewer's sample.
	50.4	0.3	0.053	18.6	Carmichael's sample.
	52.09	0.23	0.025	16.25	Lindeman's sample.
20—Magnetite	70.2	Trace	Trace	1.4	Brewer's sample.
21—Magnetite	50.0	0.24	Nil	22.0	Carmichael's sample.
22—Magnetite limestone gangue	52.6	4.2	Nil	12.1	Gold, trace; silver, 1.2 oz.; copper, 3.3%; Brewer's sample.
	66.0	Trace	Nil	3.3	Brewer's sample.
	65.8	2.2	Trace	4.8	Brewer's sample.
23—Magnetite	61.9	0.34	.....	....	Hand sample reported by Carmichael.
24—Magnetite	56.57	2.75	0.121	8.52	Lindeman's sample.
25—Magnetite	67.09	1.6	0.009	4.51	Lindeman's sample.
26—Magnetite	58.3	2.75	0.013	8.88	Lindeman's sample.
27—Bog	54.46	0.15	0.038	2.32	Lindeman's sample.
	56.97	0.447	0.038	1.40	Lindeman's sample.
	52.0	....	0.5	....	Carmichael's sample.
28—Haematite	47.6	Nil	Trace	....	Galloway's sample.
	48.4	Nil	Trace	....	Galloway's sample.
	57.0	Trace	Trace	....	Galloway's sample (selected).
					First four samples by McKenzie.
29—Limonite	54.20	1.16	0.407	1.02	Manganese, 0.85; water combined, 18.54.
	56.01	1.52	0.016	0.83	Manganese, 0.51; water combined, 16.02.
	54.32	1.14	0.065	1.99	Manganese, 0.39; water combined, 20.47.
	52.19	1.47	0.616	1.56	Manganese, 0.70; water combined, 19.61.
	51.0	1.7	Nil	2.0	Brewer's sample.
	50.6	0.8	Nil	1.7	Owner's sample.
	53.2	2.65	0.0016	1.31	Owner's sample.
	53.2	1.89	0.014	1.62	Owner's sample.
	54.0	1.15	0.002	1.04	Owner's sample.
30—Magnetite	64.81	0.158	Trace	4.21	McEvoy's samples. (See "Iron Ore Occurrences in Canada," Can. Dept. of Mines, 1917, p. 31.)
	62.03	0.170	Trace	3.85	
	63.24	0.17	Trace	4.05	
31—Magnetite	.....	....	.....	....	Ore carries too much copper to be suitable for iron-making.
32—Magnetite	50.96	0.083	0.004	25.96	Lindeman's sample.
..	55.9	1.0	.....	16.0	Carmichael's sample.
33—Magnetite	30.1	0.31	Trace	51.5	Brewers' sample.
	63.07	0.043	0.016	7.64	Lindeman's sample.

(End of Mr. Brewer's report.)

Iron Ore from Head Bay.

In view of the importance of obtaining more exact information in regard to the richness and other characteristics of the available ore, I discussed with Mr. W. F. Robertson the possibility of having a quantity of ore taken from one or more of the deposits, and sending large samples to Victoria for analysis and for tests in regard to magnetic concentration. Mr. Robertson considered that it was not necessary to undertake this at the present time, but he instructed Mr. Brewer to obtain a large general sample of ore from the deposits at Nootka sound, Head bay. In a letter from Mr. Robertson dated August 12th, 1918, and enclosing an assay certificate dated August 9th, he informs me that Mr. Brewer took nine samples from various parts of the deposit, including two near the margin. He also took a sample of the foot-wall. The nine samples were assayed separately for iron and were found to contain: 63 per cent., 70 per cent., 67.2 per cent., 63 per cent., 63 per cent., 44.8 per cent., 47.8 per cent., 67.2 per cent., and 68.2 per cent. The samples containing 44.8 and 47.8 per cent. were taken near the margin of the deposit. A composite sample was made up containing equal amounts of each of the above nine samples, and of the one foot-wall sample. This composite sample was analysed and was found to contain:—

	P.C.		P.C.
Iron	57.1	Sulphur	Trace
Silica	15.5	Phosphorus	0.05
Lime	0.6		

The average richness of the ore itself is 66 per cent. of iron, and the average richness, including the two samples near the margin, is 61.6 per cent. The composite sample contained 57.1 per cent. of iron, from which it can be calculated that the wall-rock would contain 16.8 per cent. of iron. If we assume that the samples are representative of the deposit, we learn that the rich ore contains 66 per cent. of iron, and that a general sample, including ore near the margin, and some of the wall-rock, contains 57 per cent. of iron. We may apparently conclude from this that in general mining an ore of at least 55 per cent. of iron can be expected. It appears, further, that the gangue-matter is siliceous and contains very little lime, and that the ore is free from sulphur and below the Bessemer limit in phosphorus.

The Head Bay deposits appear as Nos. 13 and 14 in Mr. Brewer's list, but Mr. Brewer does not state from which of these properties his present samples were taken, or whether the samples were taken from both

properties. The weight of the samples is also not mentioned. Mr. Robertson considers that the above results are higher than would be obtained from an average shipment of ore from this deposit.

Notes from the B. L. Thane Company.

The following notes on four deposits of iron ore in British Columbia were given me by the B. L. Thane Company, of San Francisco, and are of value as supporting the conclusion that there is available an adequate supply of magnetite ore. The analyses quoted indicate a higher grade of ore than that on which I have based this report.

Texada Island.—Deposit of magnetite owned by the Puget Sound Iron Company. The deposit contains 1,000,000 tons and probably an additional 2,900,000 tons. The ore is loaded into ships near the mine. The ore contains:—

	P.C.		P.C.
Iron	62.9	Magnesia	0.75
Silica	6.66	Nickel	0.014
Phosphorus	0.016	Cobalt	0.005
Sulphur	0.51	Copper	0.13
Alumina	1.4	Titanium	Nil
Lime	2.0	Arsenic	Nil

The estimated cost (pre-war) at a Puget Sound port was:

Mining	$0.56
Land transportation	.10
Sea transportation	.50
Royalty	.25
Fixed charges	.20
Export duty	.50
Total	$2.11

Or $3.18 per ton of pig iron.

The assumed output was 200,000 tons a year for twenty years. A tram from the mine of 1.1 miles would cost $10,000; equipment and development of mine, $290,000; total, $300,000.

Cumshewa.—A deposit of magnetite on Louise island, owned by H. K. Owens, contains 570,000 tons, with a probable 344,000 tons more. The ore is loaded into ships near the mine. The ore contains:—

	P.C.		P.C.
Iron	60.0	Sulphur	0.020
Silica	7.0	Lime	2.0
Manganese	0.83	Titanium	0.07
Phosphorus	0.008		

Pre-war cost:

Mining	$0.75
Land transportation	.15
Sea transportation	.75
Fixed charges	.71
Export duty	.50
Total	$2.86

Or $4.86 per ton of pig-iron.

Assumed output, 100,000 tons per annum for nine years. An aerial tram of 1.5 miles from mine to wharf would cost $20,000; purchase of mine, $200,000; equipment and development, $100,000; total, $320,000.

Head Bay.—A deposit of magnetite on Vancouver island, owned by Glengarry, Canadian Collieries (Dunsmuir), Limited, and Clarence Dawley, Clayoquot, contains 150,000 tons, with a probable 250,000 tons more. Ship from Nootka sound. It contains:—

	P.C.		P.C.
Iron	60.0	Phosphorus	0.008
Silica	8.0	Sulphur	0.013

Pre-war cost:

Mining	$0.90
Land transportation	.10
Sea transportation	[illegible]
Royalty	[illegible]
Fixed charges	.30
Export duty	.50
Total	$2.70

Or $4.27 per ton of pig-iron.

Assumed output, 60,000 tons per annum for seven years. Would need an aerial tram of 1.5 miles from mine to wharf, costing $20,000; development and equipment, $50,000; total, $70,000.

Quinsam Lake.—A deposit of magnetite owned by Jones & Thomson, probably contains 500,000 tons. Ship from Campbell river. It contains:—

	P.C.		P.C.
Iron	60.0	Lime	1.7
Silica	4.0	Phosphorus	0.002-0.976
Manganese	0.65	Sulphur	0.005-0.068
Alumina	2.6		

Pre-war cost:—

Mining	$0.90
Land transportation	.60
Sea transportation	.50
Royalty	.25
Fixed charges	2.12
Export duty	.50
Total	$4.87

Or $7.71 per ton of pig-iron.

Assumed output, 60,000 tons per annum for eight years. Needs a twenty-mile aerial tram, costing $220,000; development, $60,000; total, $280,000.

With regard to the estimated cost of mining and transporting these ores, we find (excepting the last in view of the unusually heavy fixed charges) the total costs to be $2.11, $2.86 and $2.70 per ton of ore. Deducting the export duty of 50c., these become $1.61, $2.36 and $2.30 per ton. Messrs. B. L. Thane consider the 1918 costs for labor, materials, transportation and capital charges would all be doubled, thus leaving a duty-free cost of $2.97, $4.22 and $4.15 per ton, or an average cost of $3.78 per ton. Remembering that these relate to outputs of 200,000 tons, 100,000 tons, and 60,000 tons respectively, it does not appear that Mr. Brewer's estimate of $4 a ton on an output of 50,000 tons is at all too high.

Notes on Cost of Mining and Transportation.

1.—Mr. W. M. Brewer, in a letter dated July 8th, 1918, writes me that he has had interviews with Mr. R. H. Stewart in regard to the cost of mining and with Captain Simon MacKenzie in regard to the cost of transportation.

Mr. Stewart stated that where the iron ore would be mined by quarrying and there would not be very much development work and only a reasonable amount of sorting, the cost of mining iron ore at the deposits on Texada island, Redonda island, and Nootka sound (Head bay) should not exceed $1 per ton, even when a quantity of only 100 tons a day was being mined. He also said that Mr. Brewer's estimate of $5,000 for the cost of installing a 3-drill compressor plant at any of these mines should be increased to about $12,000 in view of present conditions.

Captain MacKenzie stated that Mr. Brewer's estimate of $1 per ton for transporting iron ore from Texada island or Redonda island to the neighborhood of Vancouver was reasonable, provided that good dispatch were given in loading and discharging, and that a regular business could be ensured averaging not less than 700 tons a week. He also stated that if the ore was only to be hauled a short distance, as, for example, from the west coast of

Texada island or Redonda island to the east coast of Vancouver island, say in the neighborhood of Union bay, the charge for transportation should not exceed 50 cents or at the outside 75 cents per ton, provided that regular business, handling 700 tons a week, were established with reasonable dispatch, say ten hours for loading and twenty-four hours for discharging cargo. Captain MacKenzie considered that Mr. Brewer's estimate of $1.50 per ton for transporting iron ore from Nootka sound to the neighbourhood of Vancouver would be all right under reasonably normal conditions, although at the time of writing the transportation companies were asking about $3 per ton in cargoes of 700 tons.

2.—I have received from Mr. Robertson, under date of July 6th, 1918, the following memorandum re transportation of ore, etc., from Mr. H. L. Drummond, Manager, North-west Lighterage Company, Seattle.

Iron Ore from West Coast, Vancouver Island:—

In lots of 1,000 tons .. Estimated at $1.50 to $2 per ton.
In lots of 2,000 tons .. Estimated at $1.50 per ton.

Iron Ore from Texada Island (on Long Contract)—

In lots of 500 tons	90 cents per ton.
In lots of 800 tons	80 cents per ton.
In lots of 1,000 tons	65 cents per ton.

The Drummond Lighterage Company are transporting:—

Coal from Comox to Seattle at 90 cents per ton.

Coal from Nanaimo to Seattle at 75 cents per ton. They take 1,200 tons per trip, and from 15,000 to 18,000 tons per month. The charge for carrying copper ore from Sidney inlet to Tacoma is from $3.50 to $4 per ton.

Conclusions.—(1) Raising the estimate for the 3-drill plant from $5,000 to $12,000 will increase the cost of equipping each mine by $7,000, but will only increase the cost per ton of ore by about 3 cents.

(2). The original transportation estimate of $1 a ton from Texada and Redonda and $1.50 a ton from Nootka sound are supported by the above notes.

(3). With reference to the cost of mining, Mr. Robertson considers that, in view of the need of obtaining an ore of reasonable richness, the cost of mining would certainly be higher than Mr. Stewart's estimate of $1 per ton, and that $2 is as low as can safely be estimated under present conditions. We may reasonably suppose, however, that in course of time, when the industry becomes better established, and if the ore-deposits are found to be large enough, the cost of mining may possibly come down to about $1 per ton, even with the present rate of wages.

Notes on Various Iron-Ore Deposits.

1. Iron-deposit at Sarita River.—I received from the Hon. Wm. Sloan a letter date June 7th from Mr. J. F. Bledsoe, Manager of the Central Iron Committee of Vancouver Island, enclosing a note from Mr. Wm. Lorimer, of 576 Toronto Street, Victoria, B.C., in regard to the iron-ore deposit at Sarita river. Mr. Lorimer, under date of June 6th, states that this deposit has been mined to the extent of forming a dump of ore, and suggests that some of this ore should be sent to the laboratory at Victoria for treatment. He offers to sack and ship as much ore as may be required, and would make no charge for this beyond his expenses. This deposit is No. 18 in Mr. Brewer's list. It is estimated to contain probably 30,000 tons, with a possible 25,000 tons additional. The deposit is one mile and a half from deep water. It would certainly be of interest to have a quantity of this ore supplied for chemical analysis and other tests, but it will be more worth while to open up some of the larger deposits which are stiuated close to deep water. Moreover, the samples received from this deposit have been rather high in sulphur, as is shown in Mr. Brewer's report.

2. Kitchener Group, West Redonda Island, and other Deposits.—Mr. Nichol Thompson, of Vancouver, has placed at my disposal certain information respecting the iron-ore deposits in British Columbia. This includes a general synopsis of the iron-deposits in British Columbia, and reports with regard to the Kitchener group, the Elsie claim, on West Redonda Island, and other claims, from which I extract the following:—

The Kitchener group (No. 7 in Mr. Brewers' list), is located on Wigwam bay, Seymour inlet, Queen Charlotte sound. A report by G. A. Clothier, February, 1918, shows vein No. 2 to contain 65.5 per cent. iron, 4.6 per cent. insoluble, and 0.5 per cent. sulphur; and vein No. 3 to contain 64.4 per cent. iron, 1.8 per cent. insoluble, and 0.1 per cent. sulphur. Further surface work would be needed to prove the continuity of the ore-shoots on the surface before diamond-drilling to prove them at depths would be justified. A sample of the Kitchener ore supplied by Mr. Thompson of July 24th, 1916, was found to contain:—

Peroxide of iron	64.35	Iron, 64.5
Protoxide of iron	25.16	per cent.
Protoxide of manganese	0.47	
Alumina	0.96	
Lime	1.00	
Magnesia	3.89	
Sulphur	Slight trace.	
Phosphorus	Slight trace.	
Insoluble	4.70	
Total	100.53	

A report of the Elsie claim, on West Redonda island (No. 9, Mr. Brewer's list), by Alexander Sharp, Vancouver, October, 1917, contains the folowing summary: "The Elsie mineral claim has a well-defined magnetite-iron ore vein, fully 30 feet wide, probably extending from the east to the west boundary, and to depth. The ore is high grade, almost free from sulphur, phosphorus, and other impurities. Situated on tide-water, where the largest ocean-going ship can be loaded at any time, the mineral can be easily and cheaply mined."

Mr. Sharp quotes the following analyses for this ore:—

	P.C.		P.C.
Iron	65.0	Iron	61.10
Sulphur	None.	Silica	7.31
Insoluble	9.20	Lime	3.10
		Phosphorus	0.015
		Sulphur	0.?0

Some 626 tons of this ore was shipped to the Oswego Iron and Steel Company's furnace in Oregon. The average iron content was 60.8 per cent., and the ore was reported to work well in the puddling-furnace.

Mr. Thompson also supplied me with reports by J. H. Scott, of London, and W. Newman, of Vancouver, with regard to the Shoo Fly and Nellie C. claims of iron ore situated near Cardero channel, in the Coast District of British Columbia, 120 miles north of Vancouver City. The report speaks very favourably of the amount and nature of the ore, but the analyses

they quote show only 50 per cent. of iron and as much as 2 per cent. of sulphur, which does not support their statements with regard to the value of the ore. The complete analysis quoted is:—

	P.C.
Ferric oxide	51.80
Ferrous oxide	25.63
Silica	19.50
Sulphur	2.10
Phosphorus	Nil.
Titanium	Nil.
Water and oxygen	0.97
Total	100.00

Three samples assayed for sulphur showed: 1.75 per cent., 4.5 per cent., and 0.71 per cent. respectively. Eight samples assayed for iron showed: 59.7 per cent., 57.5 per cent., 54.6 per cent., 58.8 per cent., 54 per cent., 59.3 per cent., 51 per cent., and 53.2 per cent. respectively.

Metallurgical Notes

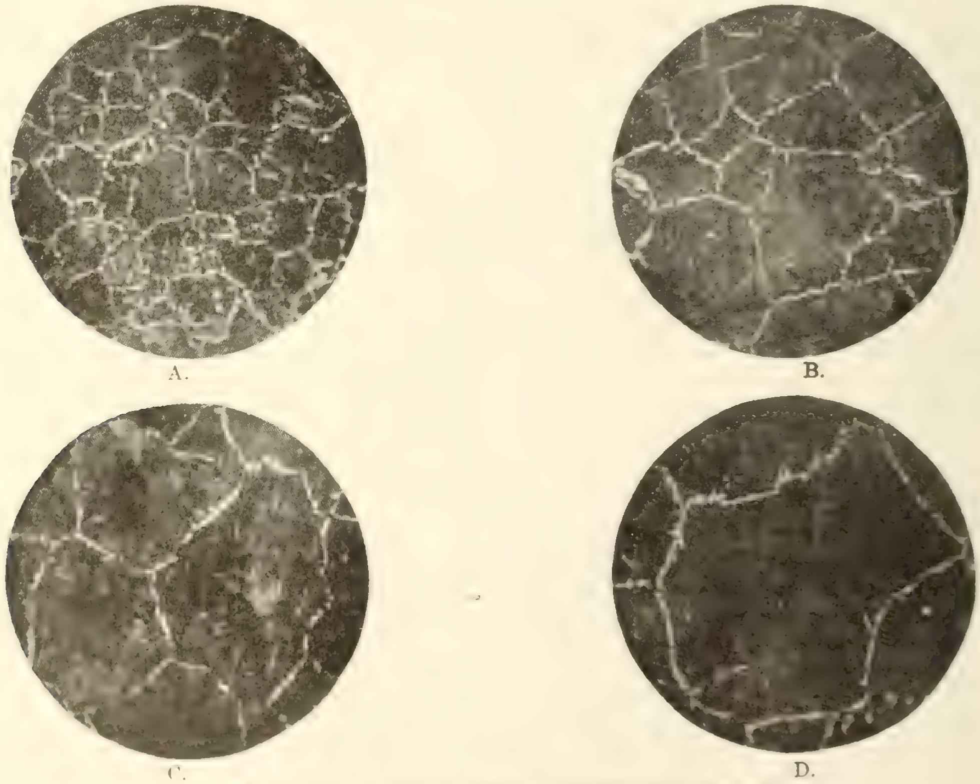
By W. G. DAUNCEY.

The Grain Size in Steel as Influenced by Rolling.

The four photomicrographs reproduced below were taken to illustrate the result of an experiment carried out at the Welland Plant of the Canadian Steel Foundries in March, 1917. It had been demonstrated that the casting of a steel blank for the production of 4.5 inch shells was not a practicable proposition, and efforts were made to cast a larger ingot and to roll this down to a 4.8 bar, which would afterwards be cut into a number of blanks of the necessary ($10\frac{1}{8}$ inch) length. With the object of showing that the major refining influence of the work done during breaking down would be absorbed before reaching the centre of the finished bar, the following investigation was made: An ingot was cast in a mould 10 inches by 10 inches at the top; 9 inches by 9 inches at the bottom, and 4 feet long. The shape of this mould was square in cross section with well rounded corners, and a brick hot-top 6 inches deep was used. The chemical composition of the steel was as follows:

C	Mn	Si	P	S
.46	.81	.23	.031	.032

and the heat was made in a 30-ton oil-fired open-hearth furnace. The ingot after stripping was re-heated in a



A. B. C. D.

Photo-micrographs of portion of rolled basic steel bar.

continuous furnace and broken down on a 22 inch mill. The reduction in size from the 10" x 10" by 9" x 9" ingot to the 4.8 inch bar was achieved by nine passes. The necessary 20 per cent discard was not removed from the ingot, but was later taken from the finished bar.

A transverse section was cut from next to the accepted portion of the bar, and from this a piece running from the outside to well past the centre was taken for microscopical examination. After polishing, and etching with a 5 per cent solution of nitric acid in alcohol, the four photomicrographs were taken. The first (A) was from 2 MM inside the outer edge; the fourth (D) was on the central axis of the bar; and (B) and (C) were from two intermediate positions. The magnification was in each case 90 diameters and an examination of the prints clearly demonstrates that the influence of work upon the refinement of grain was much more marked towards the outside of the bar than farther in. Owing to heating conditions slight decarburization is apparent in photomicrograph "A." This variation in grain size would have no bearing upon a finished forging because the blank would have to be re-heated above the temperature at which these crystals had developed. A test piece removed from as near as possible to where photomicrograph "A" was taken gave about 11 per cent higher tensile strength than one removed from the centre of the bar, where the structure was as shown at "D."

Carbon and the Composition of Steel.

In dealing with the problem of the corrosion of steel it is well to consider the probable influence of carbon compounds in iron on the electrolytic effects. When a piece of steel has been properly prepared it is possible to demonstrate that the structure is far from homogeneous, and that it contains certain clearly defined constituents. In wrought iron one sees a peculiar coarse-grained structure which is called ferrite, and from then on as the carbon increases the compound becomes steel. As the carbon percentage increase a number of peculiar and characteristic structures appear which correspond to definite compounds, solid solutions, and eutectics. It must not be assumed that all these structures are different substances, for they may be allotropic modifications or phases of one and the same substance. The carbon in steel is not, like in some cast iron, in the free state, but combined with iron forming the carbide of iron, Fe_3C. This carbide has been given the name of "cementite" from the fact that it occurs abundantly in steel treated by the cementation process. Under high power microscopical examination carbon steels exhibit a pearly lustre, owing to a finely lamellar structure. To this constituent the name pearlite has been given, and it consists of a banded structure of cementite and ferrite, in definite proportions, not a compound, but simply an intimate mixture. In hardened steel there are a number of other constituents which correspond to different quantities and conditions of the carbon. Amongst these may be mentioned austenite, martensite, troostite, osmondite, and sorbite, names given in honor of eminent metallographists. Austenite is a constituent of steel softer and less magnetic than martensite with which it is often associated. It can be produced by quenching small sections of steel containing more than 1.5 per cent of carbon in ice-cold water from a temperature of 1100 deg. C. Martensite, according to Osmond, the solid solution of carbon in iron when quenched above the recalescence point, which occurs in the neighbourhood of pearances presented by the solid solution areas during 700 deg. C. This is the name given to one of the aptheir resolution into pearlite. Osmondite, arbitrarily taken as the boundary between troostite and sorbite, or that stage in the transformation of austenite at which the solubility in dilute sulphuric acid reaches its maximum rapidity. Sorbite is the name given the appearance presented by the solid solution or hardenite during one phase of its translation into laminated pearlite. In trying to summarize the above information one may say that:

1.—The composition of all unhardened steels will be either pearlite alone, or pearlite associated with ferrite or cementite.

2.—Without taking into consideration austenite and troostite, hardened steel is composed of martensite alone, or of martensite associated with ferrite or cementite.

3.—The same piece of steel cannot contain together both ferrite and cementite.

4.—The presence of the lamelear variety of pearlite is almost certain proof that the steel has been annealed.

Accepting the definitions that ferrite is iron free from carbon, and that cementite is a compound represented by the formula Fe_3C, it becomes evident that in very low steels, say ranging from .02 to .10 the structure must be almost entirely ferrite, and that in steel containing 2.00 per cent of carbon there will be an excess of cementite. It therefore becomes apparent that there will be one point of carbon content at which the component ferrite and cementite will both be satisfied, in other words, the original proportion will be that of the eutectic alloy. This occurs in a pure steel containing about .80 per cent of carbon, the micro-structure of this grade showing no ferrite or cementite.—Journal Canadian Mining Institute, Feb., 1919.

COURSE IN METALLOGRAPHY.

The course of practical instruction in metallography, that has been given at McGill University during the past few months by Messrs. Pascoe and Roast, is now nearly ended. The course has been a very successful one, and has been greatly appreciated by those who attended it. Some of these have asked for an extension course of more advanced instruction, and others, who did not attend the first course, have enquired whether it will be repeated in the near future. We understand that if a sufficient number of students present themselves, Messrs. Pascoe and Roast are prepared to repeat the elementary course and also to give advanced instruction. All who wish to join either of these courses should apply at once to Dr. A. Stansfield, McGill University, who will be glad to answer any questions about the course. The instruction will probably begin about the 31st of March and will continue for fifteen weeks; an early start being desirable, so that the course may not extend too far into the summer.

Notes on Some Chemical Reactive Alloys

By E. A. ASHCROFT.

Paper read before the Faraday Society

The phenomena herein noted, and any prospect there may be of technical utilization of such alloys and their properties, are all based on the accidental discovery made in the course of some other researches (and I believe for the first time) of some very remarkable properties which are possessed by alloys of metals of the magnesium type with metals of the lead type, and more particularly by alloys of magnesium with lead in certain proportions—for instance, in any proportion between 5 per cent. to 50 per cent. magnesium with 95 per cent. to 50 per cent. lead. Although calcium alloys display the same properties and act somewhat similarly, they are, as far as my researches have gone, much less reactive than magnesium in this connection, and likewise lead appears to be the best base metal for the alloys. An alloy of zinc and magnesium in similar proportions appears to be less easily oxidized even than either zinc or magnesium alone.

The alloys of magnesium with lead—for instance, an alloy of 15 per cent. magnesium with 85 per cent. lead —will rapidly and completely oxidize in the cold if exposed to atmospheric oxygen and moisture, being then converted rapidly into a "jet-black" powder having the composition of magnesium hydrate and lead sub-oxide or its hydrate, $XM_0O_2H_2O + XPb_2O\ (H_2O)$ x. The reaction is complete in a few hours.

The water present up to this stage of the reaction does not take any part in the oxidization of the metals, and is not itself decomposed, but combines with the oxide of magnesium and the sub-oxide of lead to produce hydrates, the oxygen absorbed by the metals being obtained from the atmosphere. This can be easily demonstrated by confining the bases and measuring and analyzing them, but the moisture, nevertheless, is essential to the reactions, which will not take place in its absence.

For the purpose of these experiments a convenient apparatus is an ordinary Orsatt gas analysis set, fitted at the open end with a 500 c.c. exposure bottle, with the alloy (1 or 2 grams) placed in a capsule depending from the stopper, and water (about 100 c.c.) placed underneath and introduced through a separator funnel. The gases can then be both measured in volume and analyzed conveniently. A larger experiment is conveniently made by employing a large glass dessicator of known capacity, and connected by glass tubes and stopcock with a 2-litre graduated cylinder and balancing bottle, such as are used for testing calcium carbide. The gases can then be accurately measured for volume (a thermometer is placed in the dessicator, and the alloy exposed on the shelf thereof), but analysis must be made by drawing off the gases.

For these experiments, if the object is the complete removal of oxygen from any gaseous mixture, it is preferable for a small excess of alloy to be present, and likewise, if the alloy is to be completely oxidized, a little excess of oxygen mixture is preferable, but in neither case is any large excess necessary, the reactions being very complete without excess.

It is not even necessary to crush the alloy finely, although such crushing is easy on account of the brittle and friable structure of such alloys. Quite large pieces, if exposed, will rapidly oxidize and fall to powder in moist air. The temperature may be that of the ordinary air, or higher or lower.

The reactions up to this point may be expressed thus:

$$\text{(a)}\quad 2Mg+O+H_2O=MgO_2H_2;$$
$$\text{(b)}\quad 2Pb+O+H_2O=Pb_2O_2H_2.$$

The reactions are slow at first, becoming more rapid as they proceed, and are complete in a few hours.

Hydrates are formed in each case, which I have proved to be stable even when heated up to about 200° C.

Continued exposure of the product in a space from which all oxygen has been removed, or in atmospheric air containing very little or no moisture, apparently produces no further effect, but by damping the mixture it may be rapidly oxidized on further exposure to PbO_2H_2 and MgO_2H_2 with rapid and complete change of color to a light brown or pink.

For atmospheric oxidization alloys of 15 per cent. Mg are preferable to those of higher content, as the richer alloys (e.g., an alloy of 35 per cent. Mg and upwards) will not oxidize readily in the cold.

By use of this reaction, if sufficient of the alloy be exposed to combine with all the oxygen in any confined space, every trace of oxygen may be removed from any gaseous mixture containing it.

It seems therefore possible that such alloys might find useful application, both in the laboratory and also in small commercial operations for manufacturing nitrogen from the air, and for removing oxygen from any gaseous mixture in the cold. Such a process might, for instance, economically take the place of the last rectifying tower at present used in the large scale manufacture of nitrogen for conversion to ammonia cyanides or nitrates by liquefaction and fractional distillation of air.

But one may also utilize these magnesium lead or like alloys for the production of pure hydrogen gas for aircraft or other purposes. For this purpose alloys richer in Mg may be employed and 35 per cent. is a convenient strength. It is only necessary to boil such alloys in water, when reaction takes place as follows:

$$\text{(c)}\quad Mg+H_2O=MgO+H_2$$
$$\text{(d)}\quad 2Pb+H_2O=Pb_2O+H_2.$$

The reaction (c) takes place briskly. The lesser reaction (d) however, under these conditions proceeds only very slowly, and if it is required to render it rapid and complete, it is preferable to digest the alloy under a steam pressure of 100 lbs. to the square inch and a corresponding temperature of about 150° C., when the lead will be completely oxidized to PbO,

and the theoretical quantity of hydrogen liberated. The hydrogen may be drawn off from the pressure vessel with the steam and collected.

To prepare the alloys of magnesium and lead any convenient method may be employed; for instance, magnesium and lead may be readily fused together under a cover to a temperature of 700° to 800° C., and after mixing thoroughly, cooled out of contact with the air, when complete alloy will be found to have taken place, and the product can be readily broken up. Or magnesium may be precipitated from its salts into the lead by employing alkali metals or alkali metal alloys.

But to render the production of such alloys specially economical, I propose to electrolyse anhydrous magnesium chloride (which is now being produced commercially and very economically by the process for which British Letters Patent 12,873 and 13,259, both of 1916, were granted to me) over a cathode of molten lead. In such manufactures the electric energy required is the chief item of consumption, and the cost is only 2,000 kilowatt hours per ton of 15 per cent. alloy. Thus where electricity is very cheap these alloys can be obtained practically at nearly the same cost per ton as metallic lead, and the resulting useful products and effects may be obtained with a considerable degree of economy.

The electrolytic cell or apparatus consists of a cast-steel container for the alloy, having a constant level overflow weir and a return passage beneath the cell for the alloy, which is kept in steady circulation by means of a hydrogen lift device worked on the principle of the well-known airlifts used for pumping liquids. A well is provided to collect any sediment from the electrolyte, which is carried off the active surface of the cathode by the circulating alloy. The anodes are of graphite or amorphous carbon, and these are exceptionally durable in this process of electrolysis, owing to the property possessed by anhydrous magnesium chloride of precipitating as infusible and insoluble compounds of magnesium and oxygen compounds present in the salt bath. No oxygen therefore appears at the anode, which, in consequence, remains quite unaffected. The cell is sealed from the air, and provided with outlets for chlorine gas, and with constant level electrolyte overflows. The cell is supplied with lead, either molten or in pig form, and the alloy is drawn off and cooled under cover, when it may be broken up for use.

These alloys, furthermore, possess the valuable feature that they may be produced where electric energy is cheap, and then transported cheaply in sealed cans, and utilized at any remote situation. Thus, for instance, as a source of hydrogen or nitrogen for aircraft or for localized manufactures of ammonia or nitric acid, the cost of transport of the alloy would only be a small fraction of the equivalent cost of transport of the products or of an equivalent quantity of gases in cylinders. For example, the weight of material transport required to produce a given quantity of hydrogen at any remote situation will be only as 1 to 6, and of nitrogen as 1 to 10, when compared to the transport of cylinder gases. Also the wear and tear and capital sunk in cylinders and the cost of compression are all obviated. These are very substantial advantages to set against the cost of the alloys, but to them must also be added that in most instances the solid products of decomposition of the alloy are as valuable as (and sometimes much more valuable than) the alloys, so that the gases are obtained as by-products, and substantially free of cost.

The apparatus required for utilizing these alloys either at the site of their manufacture or at any distance therefrom is remarkably simple.

For the production of hydrogen by treatment with water alone, any convenient boiler or steaming apparatus with condenser for water vapour and gas collecting devices will suffice.

For the removal of oxygen from gaseous mixtures, as in the production of nitrogen, very simple devices may also be employed. For instance, an ordinary gas holder with open water tank, and possessing means for exposing the alloys in the gas space will suffice; the progress of the reaction may be noted by the movements of the gasholder. Or a smaller vessel may be employed with suitable means for exposing the alloy, over which the gases to be treated may be gently circulated by means of fans from one holder to another.

For the rest it is merely necessary to suitably proportion the time of exposure, and the temperature, composition and humidity of the gases, to the objects aimed at.

Further possible uses for these alloys may lie in the recovery of gold from cyanide solutions and in various organic reductions. For such purposes they would appear cheap and efficient as substitutes for zinc, tin, etc., as they can be very easily reduced to impalpable powder, and are extremely reactive; moreover the base, lead, is often a very convenient one to deal with in the resulting product.

Some work was also done (with the last-mentioned object immediately in view) with alloys of zinc and magnesium, which it was thought might also be used for pyrotechnic work, as a cheaper substitute for pure magnesium, as well as for the reduction processes mentioned. In this connection it is noted that the alloys of zinc and magnesium whilst very reactive both as pyrotechnic agents and as reducing agents, and very convenient in physical structure for reduction to any sized grains or powders, oxidize in the cold far less rapidly than similar alloys with lead. In fact, to atmospheric oxidization the zinc magnesium alloys display a far greater measure of resistance than does either magnesium or zinc alone, and therefore such alloys cannot be used to produce either hydrogen or nitrogen gas economically.

Magnesium zinc alloys can be manufactured very cheaply up to about 30 per cent. magnesium by the process above described, alloys being heavy enough to remain on the bottom of the cell, and form the cathode during electrolysis, which is the essential feature necessary to render the cheap production of the magnesium possible by electrolysis.

Montreal Metallurgical Association

At the Regular Meeting of the Montreal Metallurgical Association held on November the 19th, 1918, in the Macdonald Chemistry Bldg., McGill University, a very interesting discussion took place on "The Heat Treatment of Steel," in which the following took part:

Mr. A. G. Spencer gave a general introductory explanation of the purpose of Heat Treatment:

(1) To relieve strains due to casting or previous work done on the metal.
(2) To soften or anneal the metal so that it will withstand shocks or to make it easy to machine.
(3) To harden the metal so that it will withstand strain or wear.
(4) To temper the metal so that it will have certain definite physical characteristics required by the engineer.

These results are all obtained by heat treatment of various kinds, but they all depend on a knowledge of the composition of steel and of the effects of the other alloying elements and impurities found therein. Carbon is the principal element affecting the physical properties of steel, but manganese also has a place, although in a smaller degree.

Pure iron forms a definite compound with carbon, a carbide of iron containing 6.67 per cent of carbon which is termed cementite. In soft steel this cementite is associated with 6.4 times its own weight of pure iron ferrite. The resulting compound is called pearlite, on account of its laminated or wavy structure when viewed under the microscope, and it contains 0.90 per cent of carbon. An annealed steel, therefore, of 0.90 per cent carbon, is composed wholly of pearlite, while that of lower carbon content will be part pearlite and part ferrite. Steel of higher carbon content, in like manner, will contain pearlite with some free cementite.

Steel at ordinary temperatures is thus seen to be composed of a mixture of free ferrite and pearlite or free cementite and pearlite. As this mixture is heated up the pearlite is the first to change in appearance; the cementite and combined ferrite, of which it is composed, dissolve or coalesce to form a solid solution. This change begins at a definite temperature, and is completed within a definite range of temperature called the critical range. The free ferrite, or cementite is not changed until the steel is heated above the critical range when it in turn dissolves with the pearlite to form a homogeneous compound which is called austenite. The composition of austenite will vary with the amount of carbon present in the steel.

Free ferrite is soft, malleable and ductile. Pearlite is harder and less duticle than free ferrite; its hardness and other physical properties depending on whether it is finely or coarsely laminated. Austenite is hard and brittle, the degree of hardness depending on the amount of carbon. As steel is cooled down again the reverse action takes place; the excess ferrite, over that necessary to form pearlite, first separates out until the critical range is reached. In passing through the critical range, the pearlite resolves itself into its constituents of ferrite and cementite. If cooled rapidly its structure is very fine, while if slowly cooled it is quite coarse and laminated. If, instead of cooling slowly the steel is quenched at a temperature above the critical range, the above changes cannot take place, but a hardened steel is obtained intermediate between high temperature austenite and low temperature pearlite plus ferrite or cementite.

To obtain the desired results from heat treatment, it is thus seen to be necessary first to select a steel of a suitable percentage of carbon and manganese, and then to control the temperature and rate of heating and cooling, as to modify the original existing structure and to obtain the most suitable proportions and internal structure of pearlite, ferrite, etc.

Mr. Chas. Morse, formerly of the Locomotive Co. said that they had used the car type of furnace in heat treating shrapnel and were now using it for rods, axles, etc.

A member stated that at the Lymburner plant where they manufacture from 8,000 to 10,000 shells per day, no distinction in regard to the amount of carbon was made in the heat treatment, but only in annealing. The speaker asked for information with regard to quenching the inside of the shell by spraying.

Mr. Gardiner stated that at the Canadian Fairbanks-Morse plant in Toronto, several shells had been quenched by a jet of oil falling inside. His own experimental work, however, showed no advantage in spraying, and the method entailed more work.

Mr. Spencer was of the opinion that the internal spraying of long shells, such as 155 m.m., should be advantageous at any time. He had treated a 155 m.m. shell by filling it with oil through a ¾-inch pipe.

Mr. Gardiner was of the opinion that spraying would give better results, but that it was not necessary.

Mr. Sara, of the Dominion Copper Products Company found no difference between the inside and the outside of a shell. The test bars, showing from 93,000 to 95,000 lbs. ultimate strength.

Mr. Spencer stated that in his practice he found the centre appreciably softer than the skin and hoped that with the spray it would be more uniform.

Mr. G. R. Kendall made a few remarks regarding the heat treatment of steel, from the inspector's point of view. When heats of shell forgings failed on final physical test, i.e., the first test after forging, the Inspection Dept. granted permission for further treatment by the contractor, should he wish to do so. If the physical results varied very much, or were at variance from the original analyses, further chemical checks were taken before sentencing for heat treatment. If the chemical checks showed a wide variation, the heats were sentenced to be Brinell tested.

The Inspection Dept. did not specify the method to be followed in heat treatment, that being left to the discretion of the contractor. Very frequently it was necessary to grant permission for a second and even a third, or a fourth treatment. Any treatment after the second, was usually done under the supervision of a representative of the Imperial Munitions Board.

When the steel failed on account of a low yield, or a low ultimate strength, the forgings were given a normalizing treatment in which they were heated above 1,560 deg. F. and below 1,700 deg. F., removed from the furnace, and stood on end, from six inches to four feet apart, to allow of quick cooling. The failures on normalized heats were abnormally high, running from 50 per cent to 75 per cent.

The Sandberg Air Cooling process was introduced in

the Montreal District during the summer of 1917, the first installation being at the plant of the Montreal Locomotive Co., and was successful from the start. The failures from this method have been probably less than 10 per cent for the District. Highly successful as the process has been shown to be, it was but slowly installed by the different forging contractors, the latest installation not being used at all.

The Sandberg Process was developed along two lines, depending on the use of high or low pressure air. In the high pressure system, the forging was made to revolve on rollers, while the air, under high pressure, was introduced from three perforated pipes on the outside and one inside the forging. While this method was highly successful from a heat treatment point of view, it was very expensive for maintenance.

The second, or low pressure system, has pretty much displaced the first or high pressure type—in this, the forging is completely covered in a shell and a large volume of air at low pressure is blown over and into the forging.

The length of time used in each system of air cooling, varied from seven to ten minutes, for each forging; the Department insisting upon this length of time to insure that all forgings were cooled until black and were all uniformly treated.

In some of the forging plants, which were mechanically equipped, low carbon heats were air cooled direct from the press and were found to be uniformly successful. Open hearth steel having less than 0.36 per cent carbon, and less than 0.70 per cent manganese, had but little chance of passing the physical test, even on a second air cooling, but electric steel as low as 0.32 per cent carbon was successfully treated by this method.

The method of checking the temperature varied in the different plants. The most successful plant used a radiation pyrometer, and the temperature of each forging was checked on leaving the furnace: if temperature was below 1,560 deg. F. the forging was returned to the furnace. Another plant used a radiation pyrometer, but checked the temperature of the forgings before they left the furnace: the remaining plants used low resistence electric pyrometers, placed near the outlet to the furnace.

Steel failing on "high ultimate," i.e., having a strength above 49 tons, or an elongation of less than 14 per cent, was annealed by one of two methods; it was either heated in special furnaces above 1,560 deg. F. and allowed to cool in the furnace, or was withdrawn from the furnace and placed in brick lined pits; the forging being buried in ashes or well covered by steel plates.

Considerable trouble was experienced in plants handling small heats, such as were obtained from electric furnaces, the heats only yielding from twenty-five to seventy forgings. The difficulty in this case being to ensure proper supervision; the workmen sometimes annealing forgings that should have been normalized or normalizing heats that should have been annealed.

Latterly, owing to the difficulty of obtaining steel of the right composition, steel below 0.40 per cent, or from 0.55 per cent to 0.60 per cent carbon was accepted, but only at the steelmaker's risk. This was done to protect the forging contractor. When these failed on physical test, the cost of heat treatment was borne by the steelmaker and the Imperial Munitions Board. During the last six months, one of the largest steel producers in the east has been rolling rails, and previous to that, another large plant in the West was on rails for six months or more, during 1917, leaving the deficiency of shell steel to be made up by cast steel plants, either electric or open hearth.

In discussing Mr. Kendall's statements regarding the requirements demanded by the Imperial Ministry of Munitions for tensile strength, etc., of shell forgings, *Mr. Spencer* remarked that it might be interesting, as showing what could be done by proper care in selecting and controlling the methods of heat treatment of shell forgings, to mention some heats of steel differing widely in chemical composition which were so treated as to pass the required specifications. Six heats were of electric cast steel containing about 0.33 per cent carbon and 0.65 per cent manganese, and were forged and afterwards air cooled direct from the press in a blast of low pressure air. The test forgings from the different heats had each a yield point of more than 19 tons per square inch, and the ultimate strength varied from 37 to 42 tons, with over 20 per cent elongation. Another heat of acid open hearth cast steel containing 0.64 per cent carbon and 0.90 per cent manganese was annealed in a pit of ashes and the test forging showed an ultimate strength of 47 tons with a good elongation.

In comparing the requirements of the United States Ordnance specification with those of the British, Mr. Spencer further stated that the requirements demanded by the former, of oil quenching all shells after the nosing operation, should give a much stronger shell and one less likely to explode prematurely. The heating of the shell, preliminary to nosing, was likely to destroy the effects of any previous heat treatment which had been given to the forging, and to set up strains which might be dangerous in service, particularly in thin-walled shells. In shells which were heat treated subsequent to nosing this would not be the case.

Re Mr. Gardiner's request for information as to the most suitable furnace for treating large marine engine parts, he mentioned several makers of the car type of furnace, and stated that one of these was in operation at the plant of the Montreal Locomotive Co.

Mr. Pascoe—The following notes, prepared by Mr. Pascoe were read by Mr. Roast; they were well illustrated by lantern slides:

Heat treatment of steel today, for the majority of work consists of heating the steel to slightly above the highest critical point, say 1,500 deg. F., holding it at this temperature until a solid solution is formed of all the carbides and ferrite, and then quenching it in oil. When fairly cool the steel is generally slowly reheated to a temperature varying from 500 deg. F. to 1,200 deg. F., according to its composition and the hardness or ductility required.

This treatment applies to all French and American high explosive shells, to a great many automobile parts, to spring steels and practically every type of nickel, chrome-nickel and chrome-vanadium steel which have to be exceptionally tough and strong and must possess a resistance to dynamic stresses that cannot be approached by ordinary carbon steel. In all classes of medium carbon or pearlitic alloy steels the three types of strutucre shown on the screen are typical of the heat treatment.

No. 1 showing a plain carbon steel of .50 per cent carbon as rolled or annealed. The structure as observed consists of ferrite and pearlite in approximately equal proportions. This structure, except for size of grain, is also typical of annealed alloy steel such as 3 per cent

nickel steel, 1 per cent chrome and 25 per cent vanadium steel of medium carbon content, so much used in automobile construction, special spring steel, punches for hot forging work, etc.

No. 2 showing the same steel after quenching from 1,500 deg. F. in oil shows a complete change of structure. The ferrite and pearlite have gone into solid solution and have been retained to some extent in this form by the quenching.

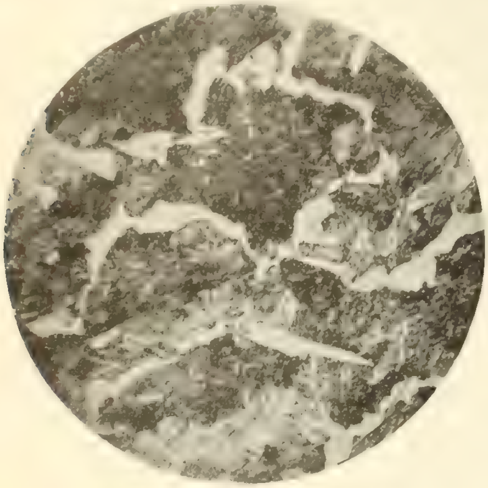


Photo-micrograph No. 1

Photo-micrograph No. 2

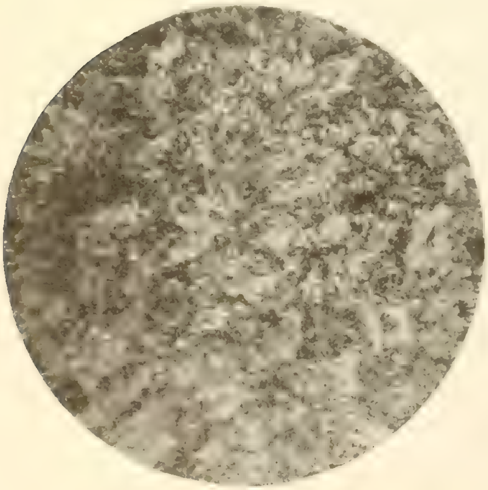


Photo-micrograph No. 3

The structure now consists entirely of martensite, which has a characteristic interlacing needle-like structure, but is of variable composition according to the carbon and alloy content of the steel. In this form the steel is generally hard and brittle and possesses very little ductility, consequently the steel is softened by heating to varying temperatures depending on the physical requirements. Usually a sorbitic structure is required to give the best results for heat-treated steels which are subject to severe shock or strain. This is obtained as before mentioned by re-heating the quenched steel, transforming the martensitic structure into transition products such as troostite, finally developing into sorbite consisting of exceedingly fine, or what may be termed, emulsified ferrite and pearlite, sometimes so fine that a very high magnification is required to resolve its constituents.

No. 3 slide shows the same steel after "drawing the temper" or re-heating to 800 deg. F. All slides are of the same magnifications, viz., 300 dia. which, in parts, barely resolves the sorbitic structure. The alloy steels of this class usually have a finer sorbitic structure under such treatment, and retain it more tenaciously than plain carbon steel when heated. The slides are interesting in view of the fact that Charpy, at the last meeting of the Iron and Steel Institute in his paper stated that he could obtain identical or superior results to forging and treating by heat treatment alone. This paper, published and commented upon by Mr. Dauncey in Iron and Steel of Canada, should be read by every metallurgist, as it is in general contrary to well accepted theories.

Mr. Robert Job: In replying to an inquiry by Mr. Gardner, said that at the Seaboard Steel Corporation near Philadelphia, and in many other plants the castings were loaded upon a car and run into the furnace, the car being protected by firebrick. The plant is very satisfactory and in general use, adding greatly to the convenience of loading and unloading the furnace, also lowering the cost of handling materials.

Mr. Job referred to the relation between tensile strength, elastic limit and elongation. Practical experience in railroad service with coarse-grained brittle rails had proved unsatisfactory, and it was decided to make a trial using fine-grained tough steel. A number of rails were cut in half, and one-half of each was annealed. The slide exhibited showed fine grain structure. The steel was highly ductile. The annealed and the untreated rails were laid alternately in track having heavy traffic, the fine-grained well-annealed rails giving poorer service. The annealing had reduced the elastic limit from 80,000 to 70,000 lbs. per square inch, giving a rail that could not stand the traffic. By increasing the carbon and thus raising the elastic limit better results were obtained. The tensile strength of both treated and untreated rails was nearly the same, though there was a wide difference in the elastic limit. Five years ago few plants in Canada, and those on a small scale only, had experience with heat treatment, although it had been adopted to a great extent in other countries, and is the basis of many industries.

A great advance has been made in heat treatment, and is a benefit derived from war conditions, also, the practical necessity of heat treatment has been clearly demonstrated. Even with the conclusion of the shell contracts heat treatment is necessary and important in many industries.

Mr. F. S. Gardiner remarked that now that the munition contracts in Canada are drawing to a close, it

might be of more interest to say a few words regarding the heat treatment of other types of steel, such as that used in manufacture of marine engines.

The building of marine engines is another new and rapidly growing industry in this country. It is required that such parts as connecting rods, piston rods, crank shafts, etc., be made out of forged steel. These forgings must be annealed before machining and further have to meet very exacting physical requirements; for instance, Lloyd's specifications for marine engine forgings require a tensile strength of from 28 to 32 long tons per square inch, and a minimum elongation of 25 per cent for steel of 32 tons tensile strength, and 29 per cent for steel of 28 tons tensile. The size of test piece is diameter .564″ and a working length of 2″. In addition to this tensile test, a bar is cut from the test coupon of section 1″ x 3/4″ and about 10″ long, must stand bending cold through 180 deg. without showing cracks or flaws.

A steel which will conform to the above requirements and which permits a variation in tensile strength of 4 tons only, is not easily obtained, owing to the enormous and ever increasing demand upon the steel mills. Such being the case, it is the duty of the metallurgist to use any steel obtainable, if it may by any chance be made to pass the specifications, and after it has been forged, endeavour to put the steel in proper condition by intelligent heat treatment to satisfy the physical test requirements. Generally when a steel of any carbon content possesses its lowest tensile strength it also possesses its maximum, or very nearly its maximum ductility. Thus, if we are using a steel, the carbon content of which is high, it should be carefully annealed and slowly cooled in the furnace to meet the above physical requirements. Slow cooling, especially through the critical range, enables the maximum amount of ferrite or pure iron crystals to separate from the iron carbon alloy, giving the best results, namely, low tensile strength and high ductility. Sometimes even with this treatment the steel will not pass the bend test, in this case a double annealing will often achieve the desired result; this is done by heating the steel above its upper critical point, say to 1,500 deg. F. slowly cooling in the furnace to 1,200 deg., re-heating to just under the upper critical point, which varies with the carbon content of the steel, but is generally in the neighbourhood of 1,350 deg. F., and then allowing the steel to cool in the furnace. This treatment will usually slightly raise the tensile strength, but gives the steel greater ductility and cold bending properties. It shows a larger reduction in area and breaks with a well cupped silky fracture. Steels on the low side of the carbon range should not be given such a thorough anneal, and should be cooled in the air. My own experience has been that any steel containing from .25 to .35 carbon and .40 to .80 manganese, if intelligently handled, will fulfill Lloyd's requirements. An ideal steel for marine engine work is .30 carbon and .50 manganese; if a steel of this composition is carefully annealed at from 1,450 to 1,500 deg. F. its physical properties should always comply with these requirements.

In regard to shell steel, the carbon content varies from .40 to .60 per cent. This wide variation necessitates very careful heat treatment of the lower carbon steel, in order to ensure that it pass the physical tests, and of the higher carbon steel, to pass physical tests and give it the proper degree of machinability for manufacturing purposes. My own experience is that it is not necessary to vary the quenching temperature with the carbon content, but that a uniform quenching temperature of 1,500 deg., with variable "draw back" or tempering temperatures of from 900 deg. to 1,300 deg. will give the desired results.

Special pieces of testing apparatus were set up. The recalescence point as shown by a thermo-couple and galvanometer was demonstrated by Mr. Roast.

A vote of thanks moved by Mr. Coughlin and seconded by Mr. Spencer, was tendered to those taking part in the discussion.

Basic Refractories For The Open Hearth

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(*Reprint of paper presented at meeting of the American Institute of Mining Engineers, New York, February,* 1919.)

Preparation and Use.—Magnesite is an important refractory in open-hearth, heating and electric furnaces for steel-making and in many of those employed in the metallurgy of copper and lead. It is sold in the form of brick, finely ground furnace magnesite for bricklaying, and dead-burned grains for making and repairing furnace bottoms. The latter are a mixture of granules varying in size from pieces of about 5/8 in. (1.6 cm.) diameter to very fine but sandy particles. Dead-burned magnesite results from calcining the crude or lightly burned mineral at a temperature that will not merely drive off practically all the CO_2, but will cause sintering of the particles. During this process the pieces shrink considerably and become hard, dense and inert to atmospheric moisture and CO_2; under-burned material, on the other hand, will hydrate on exposure to the air. From 4.5 to 8 per cent of ferric oxide is necessary for the production of a satisfactory sinter.

Dolomite has been little used for brick-making in the United States, but it is the principal ingredient of several materials offered for sale under various trade names for refractory purposes. Dolomitic refractories are almost wholly confined to the open-hearth and electric furnaces, where they are used for fettling and as substitutes for magnesite.

More magnesite and dolomite are used for basic open-hearth steel-making than for all other refractory purposes. The hearth of the furnace is usually built up of magnesite brick and dead-burned grain magnesite so laid that the brick base is protected by a working bot-

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tom of the granular material. The latter is sintered into place in layers 1 to 2 in. (2.5 to 5 cm.) thick to a total depth of 12 to 18 in. (30 to 45 cm.) at the centre of the furnace. After each heat, burned dolomite is thrown against the banks as high as it will stick, and all holes in the bottom are filled. At most plants such holes, at the end of each week, are also carefully filled with dead-burned grain magnesite. For temporary patching dolomite is generally used as it sets more quickly than magnesite and its first cost is less.

Prior to 1914, the world's supply of refractory magnesite came almost wholly from the crystalline deposits of Austria-Hungary. Its superiority lies in its high refractoriness and long range of vitrification, which enable it to frit together at high temperatures without fusion or excessive softening. These properties are imparted by a fairly high content of iron oxide, together with an extremely low percentage of harmful impurities. The dead-burned Austrian magnesite sold in the United States had the following analysis: MgO, 83.7 to 87.3 per cent; CaO, 1.9 to 3.9 per cent; SiO_2, 1.1 to 4.1 per cent; Fe_2O_3, and Al_2O_3, 4.7 to 8.6 per cent. With the cessation of shipping from Austria, magnesite was imported from Greece and Canada, domestic deposits were developed, and dolomite was substituted for magnesite where practicable. The deposits of this country are now developed sufficiently so that an adequate supply is available. Table 1 shows the great expansion of domestic production since 1914. All figures are reduced to a calcined basis, assuming 2 T. of crude magnesite equal to 1 T. of calcined.

TABLE 1.—Total Magnesite Consumption of United States on a Calcined Basis.

	1913	1914	1915	1916	1917
Imported, tons. . .	173,719	128,494	51,458	46,941	19,093
Domestic, tons. . .	4,816	5,646	15,250	77,487	158,419
Total, tons	178,535	134,140	66,708	124,428	177,512

At the beginning of the war, the refractory manufacturers were crippled by a lack of calcining facilities, since the Austrian material had been imported in the calcined condition. The low iron content of the available magnesite caused additional difficulties. In order to confer the proper sintering and bonding properties it became necessary to add iron oxide, and to incorporate it thoroughly by burning at an extremely high temperature. Magnesite thus treated, if sufficiently low in harmful impurities, is a high-grade refractory and has given conspicuously satisfactory service.

Grecian Deposits.—These deposits are of the amorphous type and had been operated on a large scale for many years, but their output was rapidly increased after the war began. Much of it is of exceptional purity, as shown by the following typical analyses of crude rock; though some was very high in CaO and SiO_2, due doubtless to improper selection at the mines. The percentage of impurities after calcination will be practically double these figures on account of the loss of CO_2.

Analyses of Crude Magnesite from Greece.

SiO_2	0.67	0.46	1.19	1.63	2.28
Al_2O_3 / Fe_2O_3	[illegible]	0.50	0.43	1.36	0.19
CaO	0.92	1.24	0.80	1.44	1.56
MgO	46.06	46.22	45.83	45.75	44.78
Ignition loss	52.16	51.51	50.42	49.88	49.76
	100.11	99.93	98.67	100.06	98.57

Magnesite of Grenville District, Quebec.—This magnesite is white to grayish, finely crystalline, and high in lime due to dolomitic inclusions. Wilson,[1] in 1917, estimated that there were in sight a little under 700,000 T. in the deposits of the district containing less than 12 per cent lime (equivalent to over 20 per cent lime when burned). It has been stated that when calcined and mixed with furnace slag or dead-burned with iron-ore, the Canadian magnesite has given satisfactory service in furnace bottoms.[2] However, the leading refractory manufacturers prefer the purer mineral of California and Washington, and endeavor to maintain the CaO content below 4 per cent in the dead-burned material. During the period of greatest scarcity of magnesite, the Canadian product was utilized by several companies in the manufacture of magnesia brick as a minor constituent of the mix, but this practice has been abandoned, and so far as the authors are aware, none of this material is now being used for brick-making purposes.

California Magnesite.—This magnesite is found amorphous at many places. It occurs in the form of veins, lenses, and stockwork in serpentine; the deposits are usually small. The largest and most important are those near Porterville, Tulare Co., and St. Helena, Napa Co. Prior to 1914, about 10,000 T. were being produced annually, hence the mines had not become sufficiently developed or equipped to produce large tonnages before the summer of 1916. Transportation was a serious problem in the rainy seasons as nearly all of the deposits are a number of miles from the railroad, and hauling to the cars is done by means of trucks. Variations in quality at first caused the users considerable difficulty. It was often hard to keep the silica and lime contents within the proper limits, due to the impurity of some deposits and the lack of uniformity in the tenor of others, as well as to the inexperience of the operators. Most of these difficulties were gradually lessened and in 1917 the production had risen to 211,663 net tons of crude magnesite.[3] In the meantime, a considerable number of calcining plants had been erected near the mines, in order to give the rock a light burning before shipment. Since a loss in weight of about 50 per cent occurs in this burning, a material saving in freight resulted. Recently the California production has fallen off, due to the competition of the larger and less expensively operated deposits of Washington. The first analysis, which is uncommonly high in iron for magnesite of this type, is representative of a unique deposit near St. Helena, Napa Co. The product is being calcined by the operators of the property and used in many steel mills on the western coast.

Typical Analyses of Californian Crude Magnesite.

SiO_2	3.25	5.18	1.10	3.86	1.55
Fe_2O_3	2.20	1.10	0.40	0.80	0.45
CaO	1.25	[illegible]	Trace	2.04	[illegible]
MgO	43.87	41.92	46.54	43.47	45.68
CO_2	49.53	48.78	51.20	49.48	50.97
	100.10	100.32	99.28	99.85	100.03

Magnesite Deposits of Washington.—These deposits have become a most important factor in the market since

[1] M. E. Wilson: Magnesite Deposits of Grenville District, Quebec. Canad. Dept. of Mines (1917) Memoir 98, 52.

[2] A. Stansfield: Iron and Coal Tr. Rev. (Jan. 12, 1917) 94, 31.

[3] C. G. Yale and R. W. Stone: Magnesite in 1917. Mineral Resources of the United States, 1917 (1918) Pt. 2, 65.

their discovery in 1916, the mineral is finely to coarsely crystalline, and shows many variations in color from white to gray, pink, red and black. Mining is done by both open-quarry and underground methods. It is reported that diamond drilling at the Finch Quarry of the Northwest Magnesite Co. has proved the existence of more than 1,000,000 T., and that on more than one of the properties an estimate of 1,000,000 T. within 200 ft. of the surface is reasonable.[4] Prior to the erection of calcining plants at the properties many thousand tons of crude rock had been shipped in which the silica content was uniformly below 3.5 per cent and lime less than 1.5 per cent. The analyses given below are typical.

Typical Analyses of Washington Magnesite.

SiO_2	1.9	3.3	4.3	0.6
Fe_2O_3 and Al_2O_3	1.0	1.0	0.8	1.2
CaO	1.7	1.4	1.1	0.5
MgO	45.2	44.8	45.0	46.4
CO_2	49.7	49.3	49.5	51.0
	99.5	99.8	100.7	99.7

Calcination is now being done near the quarries, and dead-burned magnesite for refractory use to which iron oxide is added during manufacture is being produced in rotary kilns. The material as marketed by one producer has the following average analysis: MgO, 82.5 per cent; CaO, 3.4 per cent; SiO_2, 6.5 per cent; Fe_2O_3 and Al_2O_3, 7.25 per cent; loss on ignition, 0.5 per cent.

Dolomitic Refractories.—Prior to the war few basic bottoms had been built of dolomite, which was little used except for temporary patching and the fettling between heats. Since 1914, however, calcined dolomite and specially prepared dolomitic materials have been placed in the furnace in the same manner as the grain magnesite. Within recent months the tendency on the part of steel makers has been to displace burned dolomite by specially prepared dolomites for the temporary patching and to return to the use of high-grade magnesite for all original installations and major repairs.

In the calcination of dolomite either vertical or rotary kilns may be used. In the latter case the rock is usually crushed to pass approximately a 5/8-in. (16-mm.) screen, the fine powder screened out and the granules burned. The heat applied must be sufficiently intense not merely to drive off the CO_2, but to cause the pieces to shrink and become hard and dense. The rock is frequently "double-burned" by being heated in one kiln merely high enough to drive off most of the CO_2, and further shrunk in a second at a higher temperature. The usual range of composition of the crude rock is CaO, 28 to 35 per cent; MgO, 14 to 20 per cent; SiO_2, 1 to 7 per cent; Al_2O_3, 0 to 4 per cent; Fe_2O_3, 0.5 to 5 per cent; CO_2, 43 to 46 per cent. As high a magnesia content as possible is considered desirable.

Burned dolomite as ordinarily prepared air-slakes readily on account of the high percentage of lime. For that reason it cannot be kept in stock for any length of time without deterioration and should be made just before use. In a furnace having a dolomite bottom the gas is preferably kept on even during shutdowns, otherwise a new bottom may be required on starting up again. With good magnesite this never occurs. Since dolomite does not set as solidly as magnesite, patches are more apt to become detached and float in the bath.

Special Dolomitic Refractories.—Within the last few years, numerous investigations have been undertaken in the attempt to overcome the marked slaking properties and other defects of calcined dolomite. As a result several articles consisting of specially prepared dolomite have been placed on the market under various trade names, some of which are superior to ordinary calcined dolomite, being more resistant to atmospheric slaking and giving better service in the furnace. In most of these preparations the granules are coated or impregnated with pulverized basic slag, iron ore, or similar material by burning at a high temperature in a rotary kiln. The attempt has likewise been made to coat the crushed rock with a pulverized slag suspension in water, so that upon burning a protective coating will be formed on the surface.[5] In other cases the slaking properties are diminished by using an impure dolomite, preferably one high in iron. The analysis considered most desirable may be obtained by mixing raw rock of different compositions.

One patented material is prepared by grinding together dolomite and iron ore to form an intimate mixture and calcining at a temperature reported to exceed 2850° F. (1565° C.). The finished product for furnace bottoms is said to show the following range of analysis: CaO, 42 to 55 per cent; MgO, 38 to 25 per cent; SiO_2, 6 to 13 per cent; FeO_3 and Al_2O_3, 8 to 14 per cent.

Another compound consists of an intimate mixture of granular dolomite and about 10 per cent basic open-hearth slag. The manufacturers prefer hard, compact and dense varieties of dolomite, as high as possible in magnesia. It is said that the granules, after calcination in a rotary kiln at about 2800° F. (1540° C.) are mixed, upon coming from the kiln and while still hot, with the granulated slag and the mixture is sent through a rotary cooler. It is claimed by the manufacturers that material thus prepared may be transported without slaking when the magnesia content is high and the dolomite is extremely hard burned. The average analyses of several shipments is given herewith: CaO, 48 to 55 per cent; MgO, 29 to 32 per cent; SiO_2, 4 to 11.5 per cent; Al_2O_3, 3 to 6.5 per cent; Fe_2O_3, 4 to 7 per cent.

Laboratory Tests.

The relative value of different materials used in the open-hearth furnace is measured by the service obtained and by that alone. Neither theoretical considerations nor the results of laboratory tests can be expected to demonstrate precisely what these relative values may be, although much can be learned from such studies. With these facts in mind, the authors some months ago planned a brief series of tests designed to compare properties of various basic materials that evidently affect the durability of these materials in the furnace. The results of these experiments, which were carried out under the direction of Raymond M. Howe, at the Mellon Institute of Industrial Research of the University of Pittsburgh, are described here.

The wearing away of the basic bottom is due to the abrasive action of the slag and metal frothering during the process of oxidation, the scouring out of holes caused by boiling when the heat becomes excessive, chemical reactions between constituents of the hearth and of the bath or slag, and possibly a few other minor causes. It is not to be expected that furnace conditions can be reproduced in laboratory tests; these are merely be so arranged as to show the relative resistance of different

[4] Yale and Stone: Op. cit.

[5] A. V. Bleininger: Some Aspects of the Testing of Refractories, Proc. Eng. Soc. West Pa. (1916-1917) 32, 612.

materials to destructive forces logically assumed to be similar to certain of those in the furnace.

It is well known that all basic refractories soften at high temperatures and it is believed that the softer the bottom the more rapidly will the scouring action take place. Other things being equal, the material that shows the least degree of softening at operating temperatures should give the longest service. Tests were therefore made to determine this property.

Corrosion of the lining due to chemical action is harmful, not only because of the wearing away of the refractory but because the surface of the hearth becomes weakened and less resistant to abrasion. It has been suggested that the impurity in the melt most likely to have a strongly corrosive action upon the lining is phosphorus and that the reason magnesite bottoms last longer than dolomite bottoms is due largely to the superior resistance of magnesite to the oxides of phosphorus, which have a strong affinity for lime. An investigation regarding the relative resistance of various basic refractory products to the action of a corrosive melt high in phosphorus is included in the tests here described. The ignition loss of basic refractories should be as low as possible, since a high ignition loss results in excessive wastage in the furnace. The rate at which different materials absorb moisture and CO_2 has been studied in this connection.

Basic Materials Studied.—The six materials studied include two magnesites, two dolomites, and two specially treated dolomites. Throughout the remainder of the paper these will be designated by the letters *A*, *B*, *C*, *D*, *E*, and *F*. The material designated as *A* was prepared from Washington magnesite, ground with ferric oxide, and dead burned. *B* is a similar product prepared from Canadian magnesite. C is a preparation made by coating dolomite granules at a high temperature with basic open-hearth slag. *D* is made by mixing together iron oxide and dolomite and calcining at a high temperature. *E* is a relatively impure dolomite that has been calcined. *F* is a rather pure dolomite that has been double burned. The analyses of these materials at the time of arrival are given, also these analyses recalculated on a zero ignition loss basis to make them more comparable.

Analyses of Basic Materials.

	A	B	C	D	E	F
Moisture and ignition loss per cent.	0.43	0.33	0.47	1.00	3.70	9.90
Silica, per cent.	7.36	4.56	11.46	9.84	6.68	2.16
Alumina, per cent.	2.33	2.08	3.91	1.86	3.89	0.90
Ferric oxide, per cent.	4.81	7.88	4.41	4.54	1.69	1.10
Lime, per cent.	3.12	18.94	47.92	48.70	49.84	51.00
Megnesia, per cent.	81.60	66.40	32.10	34.73	34.50	34.85
Total	99.63	100.19	100.27	100.67	100.30	99.91

Recalculated Analyses of Basic Materials.

	A	B	C	D	E	F
Silica	7.40	4.57	11.52	9.94	6.93	2.40
Alumina	2.34	2.08	3.93	1.88	4.03	1.00
Ferric oxide.	4.83	7.89	4.43	4.58	1.73	1.22
Lime	3.13	18.96	48.15	49.19	51.64	56.61
Magnesia	81.93	66.66	32.26	35.18	35.75	38.69
Total	99.63	100.16	100.29	100.77	100.08	99.92

Slaking Tests.—From the very manner in which basic materials are prepared, it can be assumed that a low ignition loss and the least possible tendency to slake are essential properties. Buyers of refractory products do not wish to pay for something that is lost as soon as the material is heated. For example, the 10 per cent ignition loss of *F* will cause the loss of considerable money were such material to be used on an extensive scale.

It has been said that those materials "powder" more or less as they give off CO_2 or water during heating. A part of this powder is carried out of the furnace by the draft, resulting in an additional loss in material, as well as injury to the checkers. It is suggested that the driving off of moisture and CO_2 under the action of the heat may interfere with proper setting of the granules to a dense mass and thereby decrease the resistance to erosion.

Because of the seriousness of the slaking problem, two methods of procedure were followed. In the first, the materials were allowed to stand exposed to the air, and each month a sample was taken, dried at 110° C., and its ignition loss determined. The results of this series of tests are not yet available. The second procedure consisted of moistening the different materials from time to time with water. Samples were then taken at intervals of 5 days, dried at 110° C., and the loss on ignition determined. The results are given in Table 2. Table 3 represents the ignition loss of recalcined *E* and *F*; it was deemed necessary to recalcine these two products because of their high loss at the beginning of the test.

TABLE 2.—Percentage Loss on Ignition at Regular Intervals.

	A	B	C	D	E	F
Loss at beginning of slaking test.	0.02	0.20	0.08	0.95	3.93	14.04
Loss after 5 days	0.48	0.69	1.20	5.67	18.45	25.52
Loss after 10 days	0.95	1.25	1.62	8.35	20.00	26.30
Loss after 15 days	1.24	1.94	2.39	10.10	23.30	33.00
Loss after 20 days	1.36	1.92	3.01	10.92	23.66	29.70
Loss after 25 days	2.09	2.65	6.30	12.00	24.33	25.99
Loss after 30 days	2.54	3.25	4.63	14.99	24.67	30.81

TABLE 3.—Percentage of Loss Upon Ignition of Recalcined E and F.

	E	F
Loss after recalcination	1.55	1.29
After 1 day	5.16	9.74
After 2 days	9.40	
After 3 days	12.79	15.81
After 5 days	12.81	16.43
After 10 days	15.80	
After 12 days	.....	23.53
After 15 days	17.09	
After 20 days		
After 25 days	17.36	
After 30 days		

The results given in these Tables are also plotted graphically in Fig. 1. Table 4 gives the analytical and slaking data.

TABLE 4.—Analytic and Slaking Data.

Material	A	B	C	D	E	F
Order of resistance to slacking	I	II	III	IV	V	VI
Lime content, per cent.	3.16	18.96	48.15	49.19	51.64	56.61
Magnesia, per cent.	81.72	66.66	32.26	35.18	35.75	38.69
Silica, alumina and ferric oxide, per cent.	14.70	14.54	19.88	16.40	12.69	4.62

It is to be observed that in the case of both magne-

sites and dolomites the slaking tendency increases directly with the lime content and that in the case of the dolomites it varies inversely with the sums of the iron, silica, oxide and alumina contents. The state of these impurities, whether they are natural or artificial, undoubtedly exerts an influence that these tests do not reveal. In the latter case the thoroughness with which the granules are coated or impregnated with ore or slag is an important factor. The low-slaking tendency of *C* apparently proves that the granules were well protected by the slag coating. It is somewhat higher in impurities and lower in lime than *D*, a treated dolomite that slaked badly. *E* was the more stable of the two calcined dolomites; its condition at the time of receipt was far superior to that of *F*. It is believed that these two cases serve as the best examples of the effect of lime content and fluxes upon the rate of slaking.

A study of the figures given indicates that the lime content should be as low as possible and that iron oxide, alumina, and silica, the limits depending on the character of the dolomite and its treatment, are necessary in dolomitic refractories, if the slaking is to be kept within practicable limits; further, that a dead-burned magnesite free from lime, and possibly containing a fairly high percentage of impurities (10 to 15 per cent of SiO_2, Al_2O_3, and Fe_2O_3) is the most suitable basic refractory for withstanding the conditions of this test. These conditions represent the influences to which basic materials may often be subjected in cars or when stored in the plant. Pure calcined limestone is the poorest material to withstand such conditions. Other combinations of the lime-magnesia series will arrange themselves in intermediate positions according to the lime, alumina, silica, and ferric oxide content, and the temperature of burning. The air-slaking series, although incomplete, indicates that the different materials stand in the same relative order as given above.

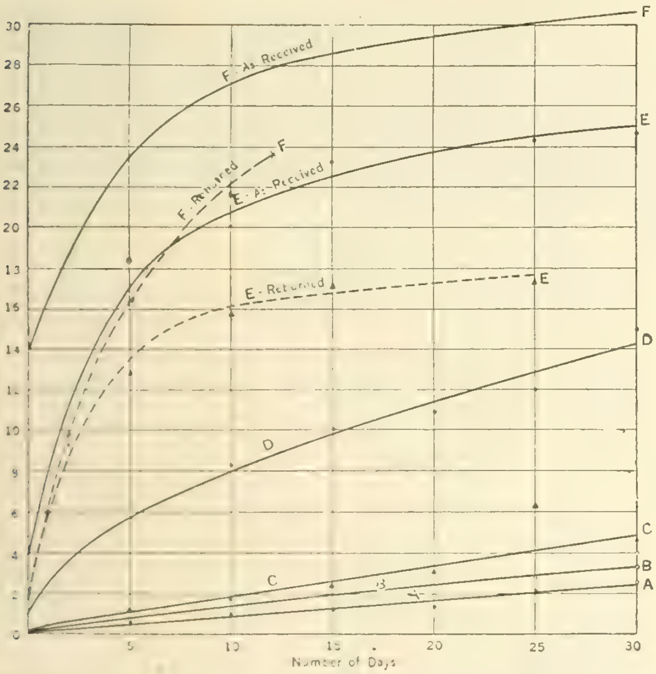


Fig. 1.—Increase of Loss of Ignition of Basic Materials Under the Influence of Moisture.

Action Between Basic Materials and Fireclay or Silica Brick.—Failure is liable to result because of chemical reactions when basic materials are in contact with fireclay or silica brick at high temperatures. The latter are not uncommonly used in contact with magnesia brick above the slag line of the open hearth, but this is not considered the best practice and a buffer layer of chrome brick is desirable. With this exception the basic materials are generally carefully separated from silica and clay brick in furnace practice. In view of these facts the following tests were made to show the relative limits of safety when the materials mentioned are heated in contact. Morover, it was believed that the behavior of the basic products in this test would afford an indication of their relative chemical activity and a measure of their probable resistance to corrosion in the furnace.

Cones sawed from bricks and placed in pats of basic materials were treated in a pot furnace together with a fireclay pat containing standard cones. Specimen *A* was found, after a few trials, to react with firebrick between cone 18 and cone 26. A pat was then heated rapidly to cone 18, but though this temperature was held for 3 hr. no action was observed. Another pat at cone 18 showed the same result. A third pat heated to cone 20 and held for 3 hr. resulted in a violent reaction between the magnesite and firebrick. This procedure was followed in each case.

TABLE 5.—Reacting Temperatures in Cones between Basic Materials and Brick.

Material	Fire Brick Cone	Silica Brick Cone	Lime Content of Basic Material, Per Cent.
A	20	26+	3.16
B	18	18+	18.96
C	15	16+	49.19
D	15	16+	48.15

The figures given in Table 5 illustrate the tendency of lime to lower the reacting temperature and increase the chemical activity of the basic refractories. It is probable that the temperatures shown are much too high for practical limits of safety, and that they are only relatively true.

A close examination of Fig. 2 shows that the firebrick formed a thin liquid and ran into the magnesite; the shadows show where the firebrick had been. The silica brick cones behaved differently and can be seen as they were at the end of the test, having cut away the magnesite without the formation of a visible slag.

Crucible Test.—Basic refractories, besides withstanding slaking and erosion, must resist considerable chemical action. Carbon, phosphorus, and silicon are present in the metal bath in the form of carbides, phosphides, silicides, or in an oxidized condition. The oxides of phosphorus are known to have a marked affinity for lime, for which reason basic materials high in lime should be expected to give less service in the furnace hearth than materials low in this oxide, notwithstanding the additions of lime made to slag the phosphorus. The lining is necessarily exposed, at least locally, to the corrosive influence of phosphorus in the melt until it is removed. A series of crucible tests was, therefore, conducted for the purpose of studying the action of phosphorus compounds on the six basic materials.

The general plan was to make crucibles of the different products, heat them to a certain temperature, introduce a corrosive mixture, allow it to react for equal lengths of time upon the different crucibles, cool, and analyze the melted portion for silica, lime and magnesia.

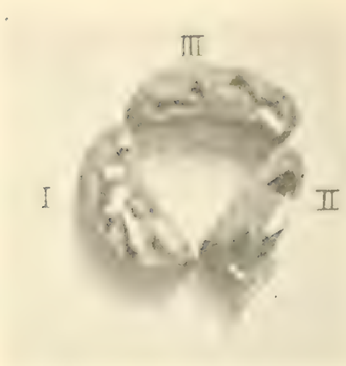


Fig. 2.—Pats Showing Action of Magnesite Upon Firebrick and Silica Brick. I. Orton Cones in Clay Pat. II. Silica Brick Cones in Magnesite Pat. III. Firebrick Cones in Magnesite Pat.

Since these three oxides could come only from the crucible their presence in the melt would prove chemical action.

Crucible series 1 involved the use of crucibles 3.5 in. (8.8 cm.) in diameter and 2.5 in. (6.2 cm.) in height, made from the materials as received and bonded by means of gum tragacanth. It was impossible to make crucibles of the above type from material *F* so the basic materials were packed in fireclay crucibles 3 in. (7.6 cm.) in diameter and 4 in. (10cm.) in height in series II, III, and IV. In either case the corrosive mixture added consisted of one part ferrophosphide and two parts ferric oxide, which was used to oxidize the phosphide and was itself reduced in the process. The mixture was added to the hot crucibles by means of an iron ladle. At the conclusion of the melting period the crucibles were cooled, sawed vertically through the center, and samples taken from the melt for analysis.

In the first series of test the crucibles were heated to 1350° C., 100 gm. of the corrosive mixture was added and allowed to react at this temperature 2 hr. The crucibles are shown in Fig. 3. In the second series, the crucibles were heated to 1300° C. when 100 gm. of corrosive mixture was allowed to react upon them for ½ hr.; the action at the end of this time was too slight to be determined. In the third series of tests, the crucibles were heated to 1300° C. and 100 gm. of corrosive mixture was allowed to react at this temperature for ½ hr.; then the temperature of the furnace was increased to 1350° C. and 50 more gm, of slag was added, the temperature being held constant for ½ hr. The extent of the corrosive action is shown by Fig. 4. The fourth series of tests was conducted by heating the crucibles to 1300° C. and adding 100 gm. of corrosive mixture; after ½ hr. the furnace temperature was raised to 1350° and 50 gm. more introduced; ½ hr. later an additional 50 gm. of mixture was added and the temperature maintained ½ hr. longer. Partial analyses of the slags or melts from these tests are given in Table 6.

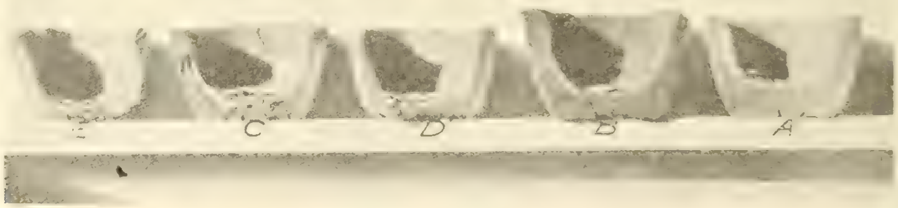


Fig. 3.—Crucibles Used in Crucible Series. I.

The analyses of the slags from crucibles *C*, *D*, and *F* in the fourth series should not be compared with those of the same crucibles given in the preceding tests since under the more severe conditions of this test additional reactions came into play. The Fe_3P-Fe_2O_3 mixture had eaten through the bottoms of crucibles *C*, *D*, and *F* as shown in Fig. 5, and a series of reactions resulted between the corrosive mixture, the basic material, and the clay of the crucible, with the formation of a very active fluid slag. The silica, lime, and magnesia contents of this slag were influenced by the action of the clay as well as by that of the phosphorus. These tests show

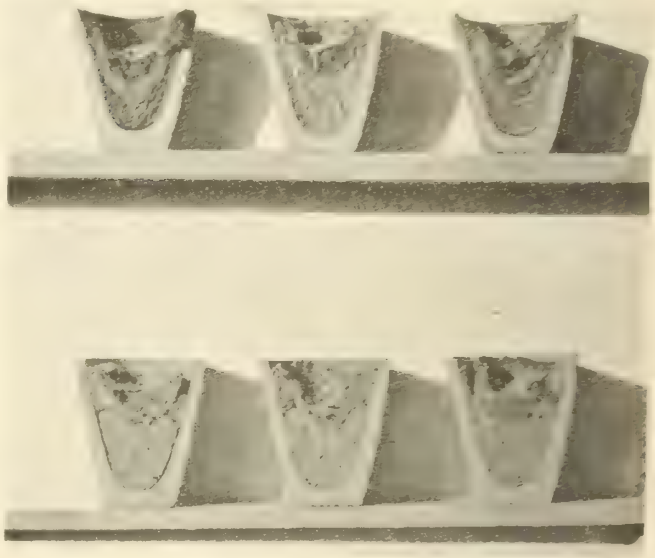


Fig. 4.—Crucibles Used in Crucible Series III.

that the average order of resistance of the various basic materials to the action of the corrosive mixture places the low-lime magnesite first, the high-lime magnesite second, a treated dolomite third, the calcined dolomite fourth, another treated dolomite and the double-burned dolomite fifth and sixth respectively. The materials lowest in lime offered the most resistance to the action of this corrosive mixture. The superiority of the low-lime magnesite, the intermediate position of the high-lime magnesite, and the general lower resistance of the dolomites establish this conclusively. Other oxides as well as lime were taken into the solution but the intensity of this action seems to have been dependent on the amount of lime present. Only limited conclusions can be drawn from these results. Other factors being the same, it should be expected that the basic refractories lowest in lime should give the best service where exposed to the corrosive action of melts containing phosphorus, such as those of the basic open-hearth furnace. However, the relative value of the materials studied can merely be approximated.

Analysis of the slags from the specially treated dolo-

mites gave unexpected results. Material *C* showed somewhat greater resistance to corrosion than the calcined impure dolomite *E;* at the same time material *D*, another specially treated product, was decidedly inferior to *E* and *F*, both dolomites that had been calcined without any effort to coat or protect the granules by special methods. To what extent the special treatment accorded the patented dolomitic products is an advantage in increasing the resistance to corrosion is open to question. The preceding tests have served to distinguish between magnesites and dolomites. The latter part of the work applies to magnesites only, and the tests were made somewhat more severe in order to secure more pronounced results.

Crucible Tests on Magnesites. Crucibles made of magnesite grains were subjected to tests similar to those described but under more severe conditions. Crucibles like those employed in the first series were used.

Partial Analyses of Slags from Crucible Tests.

Material	A	B.
Silica	2.56	2.96
Lime	0.40	2.28
Magnesia	2.46	6.38
Total	5.42	11.62

bottoms, for the boiling of the bath will have a greater tendency to scour out holes in a hearth that is soft than in one that is more rigid. In order to study the rigidity of magnesites *A* and *B* at high temperatures, bricks having the compositions given were made from each by the usual brick-making methods, and subjected to a load test. These bricks were heated under a load of 25 lb. per sq. in. (1.7 per sq. cm.), applied on the end of the brick with a temperature increase of 250° C. per hr., until failure resulted. Brick *A* failed by shearing at 1555° C., evidently due to a breaking of the bond; brick *B* did not shear but softened and settled at high temperatures. By the time 1450° C. had been reached, it had shortened 12.5 per cent of its original length, see Fig. 6.

Since magnesite *A* shows no evidence of softening at the temperature of the test while magnesite *B* shows considerable, it is to be expected that the former should show a much greater resistance to the erosion of boiling metal than the latter.

Fusion Tests.—The difference in softening temperatures of the two magnesites indicated that fusion-point data might be of value. It was hoped that the fusion points of the magnesites and also of intimate mixtures of finely ground slag and magnesite might be obtained. Were the latter possible, comparative values could be

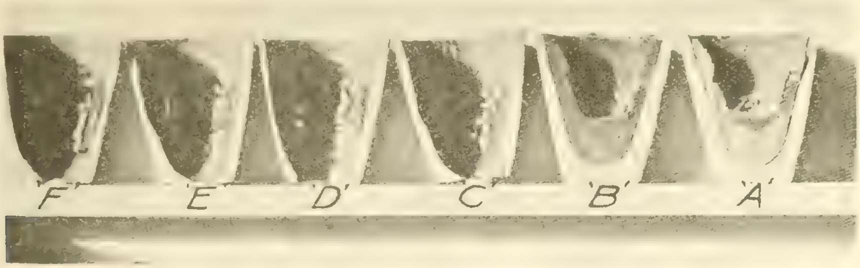


Fig. 5.—Crucibles Used in Crucible Series IV.

TABLE 6.—Partial Results of Crucible Tests.

	Analyses of Slags from First Tests				Analyses of Melts from Third Series				Analyses of Slags from Fourth Series				
Material	Silica	Lime	Magnesia	Total	Silica	Lime	Magnesia	Total	Silicia	Lime	Magnesia	Total	Average Order of Resistance
A	0.00	0.12	1.30	1.42	0.21	0.08	0.35	0.64	0.32	0.04	1.23	1.59	1.00
B	0.31	0.10	1.33	1.74	0.34	0.22	1.55	2.11	0.74	0.46	3.52	4.72	2.33
C	0.64	0.81	0.69	2.14	2.24	1.42	1.58	5.24	6.20	7.48	4.18	17.86	3.00
D	0.64	1.48	1.47	3.59	9.98	4.55	6.86	21.39	18.90	22.14	14.90	55.95	5.33
E	0.51	0.83	0.64	1.98	1.82	1.13	1.58	4.53	1.56	1.44	1.53	4.53	3.67
F	....	....	....	....	1.72	5.37	5.42	12.51	24.52	12.70	8.12	45.34	5.00

Analyses of Magnesite Bricks.

Material	A	B.
Ignition loss	0.26	0.37
Silica	7.26	5.72
Alumina	2.14	2.00
Ferric oxide	4.95	5.94
Lime	3.18	15.05
Magnesia	82.40	70.84
Total	100.19	99.92

and 600 gm. of the corrosive mixture added hourly in 150-gm. batches. A temperature of 1350° C. was maintained for 4 hr. The marked superiority of magnesite *A*, in resistance to corrosion, was shown in the preceding experiments and is developed even more strikingly in this one.

Load Tests.—It seems probable that unsatisfactory service would be caused by any marked softening of the

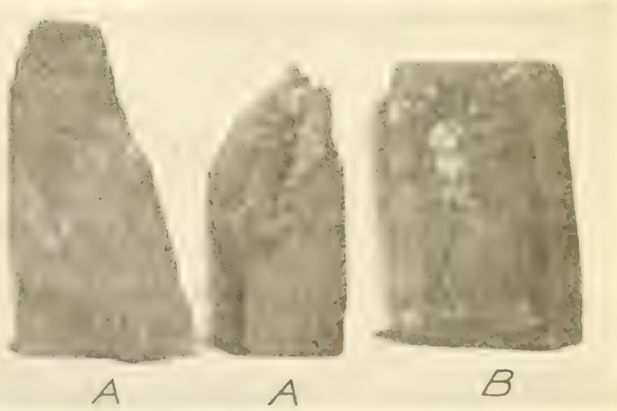


Fig. 6.—A Typical Failure of Brick A in Load Test.. B. Failure of Brick B in Load Test. Original Dimensions 8.75 in. by 4.13 in.; Final Dimensions, 7.66 in. by 4.31 in. by 2.72 in.

established. One could state, for example, that a mixture of 80 per cent of magnesite *X* and 20 per cent of slag was equivalent to a mixture of 60 per cent of magnesite *Y* and 40 per cent of slag. Cones were accordingly made up, some of 100 per cent magnesite and others of magnesite mixed with from 10 to 90 per cent of basic open-hearth slag. In the endeavor to compare the fusion points of these mixtures with those of Orton cones numerous difficulties were encountered.

It was first necessary to devise a method for placing the test pieces in material that would be neutral to both cones and magnesite. After several failures, successful cone pats were made in the following manner. One half of the pat was made of fireclay and Orton cones were placed in this; the other half, in which the test cones were placed, was made of magnesite. The two half pats were joined to form a disk 3 in. in diameter and finely ground chrome ore used at the junction to separate the magnesite and fireclay. The disk was then placed upon a fireclay pedestal that had been sprinkled with crushed chrome ore. This combination was necessary to prevent the magnesite from attacking the high-temperature Orton cones, or the fireclay of the pat.

When the method for conducting the tests had been devised, it was found that the slag ran from the cones at high temperatures and left a magnesite shell standing. The results of such tests were therefore disappointing. Slightly better but inconclusive results were obtained when ferric oxide was used in place of the slag. Cones of 100 per cent magnesite also gave poor results, because of the tendency of this material to volatilize at high temperatures.

Bar Tests.—In discussing fusions, it was suggested that a test that would determine the relative values of different basic materials when mixed with varying amounts of slag would be of value. The load test indicated differences in the softening points of magnesites *A* and *B* but the attempted study of fusion points revealed nothing. It was hoped, therefore, that a series of bar tests, conducted in the following manner, would combine information that might have been secured from the other two.

Magnesite and basic open-hearth slag were ground to pass 60-mesh, weighed out in the proportions indicated, and mixed with gum tragacanth. The mixtures were molded into bars 1 in. by 3/8 in. $\times$ 6 in. (2.5 $\times$ 0.9 $\times$ 15 cm.), which, when dry, were strong enough to be introduced into the furnace. They were laid flat on silica brick and heated to 1250° C., a temperature sufficient to produce a certain amount of sintering. The sintered bars were placed in a test furnace and supported between bricks placed 4½ in. (12 cm.) apart,

Fig. 7.—Typical Bar Test Results.

being separated from the latter by chrome ore powder. The furnace was then heated at the rate of 100° C. temperature increase per hour, and the softening points were observed. The observations are given in Tables 7 and 8.

TABLE 7.—Bar-test Data with Magnesite A.

Mixture	Furnace Temperature at which Softening Began, in Degrees C.	Remarks
100% *A*	Samples broke	Too refractory to become bonded by this treatment.
70% *A* + 30% slag	1370	Action complete (sagging of 2 in.) in about 2 min.
60% *A* + 40% slag	1350	
50% *A* + 50% slag	1350	
40% *A* + 60% slag	1350	
30% *A* + 70% slag	1345	
25% *A* + 75% slag	1340	
20% *A* + 80% slag	1330	
15% *A* + 85% slag	1320	
10% *A* + 90% slag	1310	

These mixtures showed no evidence of softening until the temperature of failure had been reached. In the entire series sagging began at a point above the fusion point of the slag, which melts at 1290° to 1300° C.

TABLE 8.—Bar-test Data with Magnesite B.

Mixture	Furnace Temperature at which Softening and Sagging Began, in Degrees C.	Remarks
100% *B*	1285	These bars sagged about 1 in. in 1 hr. when 1350° C. had been reached.
95% *B* + 5% slag	1280	
90% *B* + 10% slag	1260	Had sagged 2 in. at 1340° C.
85% *B* + 15% slag	1275	Had sagged 2 in. at 1350° C.
80% *B* + 20% slag	1280	
70% *B* + 30% slag	1260	
60% *B* + 40% slag	1250	
50% *B* + 50% slag	1260	

All magnesite *B* bars, as shown in Table 8, began to soften about 1 hr. before the action was complete (when they had sagged 2 in), and at about the melting point of the slag or a trifle lower. The temperatures at which the bars had sagged 2 in. were nearly the same when appreciable amounts of slag were present

The results of the bar tests are not easy to interpret and it is not possible to state that the softening tendency of a slag-magnesite mixture of one series is equivalent to that of a definite mixture of the other. Failure of the bars evidently occurred through softening and fusion of the slag. The melting temperature of the latter seems to have been raised by admixture with magnesite *A*, and depressed by magnesite *B*. What the significance of the latter fact may be is not clear.

SUMMARY.

1 *Comparison of Low-lime and High-lime Magnesite.* The magnesite that was the lower in lime showed less tendency to slake and higher refractoriness, as well as greater resistance to attack by firebrick and silica brick, and to the action of a corrosive Fe_3P-Fe_2O_3 mixture.

2. *Comparison of Dolomitic Materials.*—The materials highest in impurities and lowest in lime were most resistant to slaking. With one specially prepared dolomite *C* in which the granules had been coated with basic open-hearth slag, the inherent tendency of dolomite to slake had been overcome to a great extent. Another special preparation of similar character *D* showed practically the same degree of slaking as the untreated dolomites. A specially treated dolomite *C* withstood the action of the corrosive mixture only slightly better than an untreated dolomite high in impurities, and much better than the second special preparation *O*. The purest dolomite showed the poorest resistanc to corrosion, although this may perhaps be explained by the high ignition loss of the material as received and used.

3. *Comparison of Magnesite and Dolomite.* — The magnesites are more resistant to slaking than the dolomites or dolomitic preparations also to the action of the corrosive Fe_3P-Fe_2O_3 mixture and that of fireclay and silica. One of the specially treated dolomites has a slaking tendency so low as to group it with the magnesites as far as this property is concerned. However, in resistance to corrosion it compares more closely with the untreated calcined dolomite high in impurities.

Considering these tests only, the value for refractory purposes of the materials studied may be placed in the following orders. First, *A*, a magnesite low in lime; second, *B*, a magnesite high in lime; third, *C*, a treated dolomite; fourth, *D*, a calcined dolomite high in impurities; fifth, *E*, a treated dolomite; sixth, *F*, a pure calcined dolomite low in impurities.

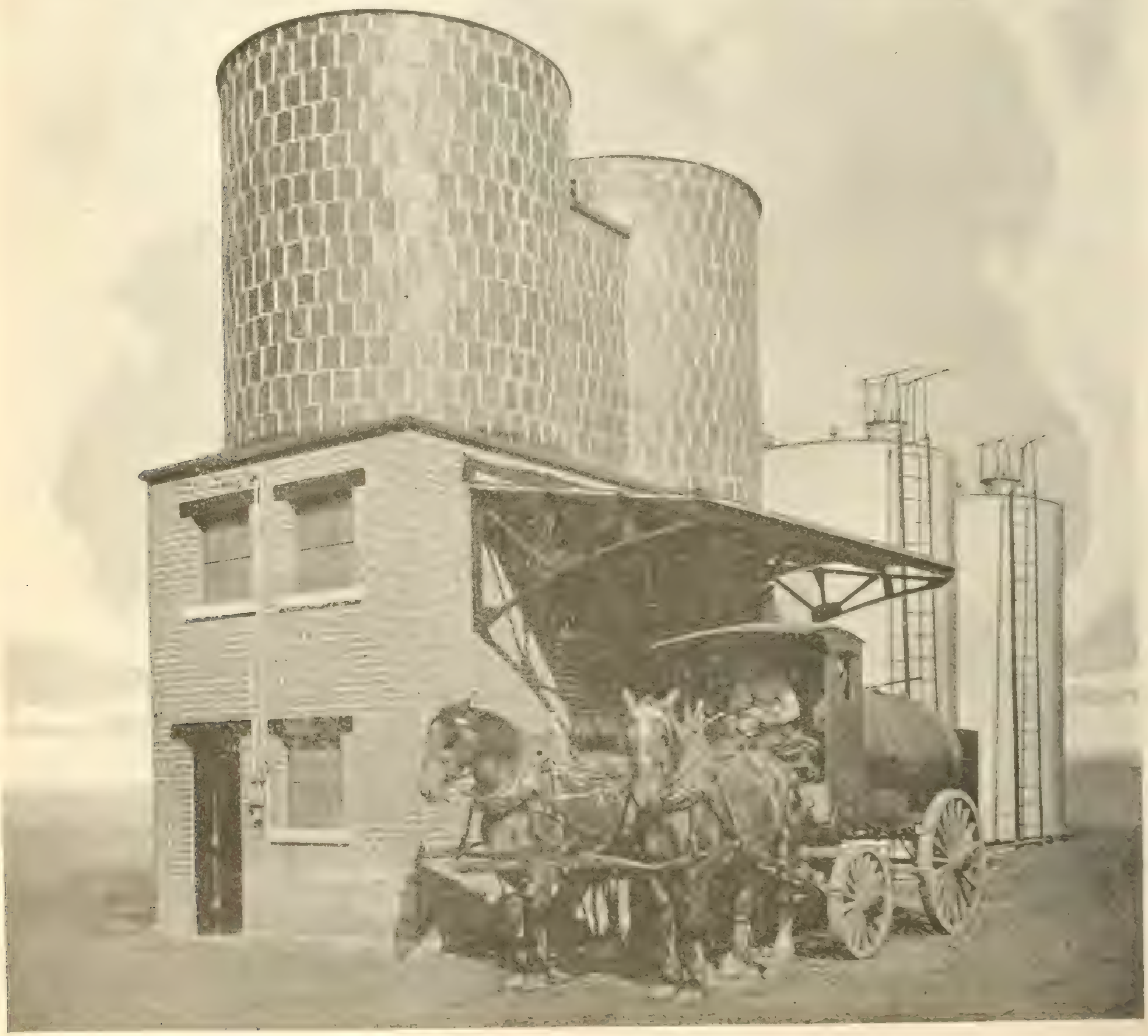
Distribution and Storage Plant of "Imperial Oil, Ltd.," at Hamilton, Ont.

The present business of the new Imperial Oil plant dates back to 1899, when "The Hamilton Oil Co." began business in the old premises of the present company. After several changes and amalgamations this old plant became "The Hamilton Branch of the Queen City Division of Imperial Oil, Limited," which title it bears at the present time. The old storage plant of Imperial Oil was quite too small for the very rapidly increasing business of the company. Not only was this true as to storage facilities but also with regard to distribution, and a new and up-to-date plant became imperative.

The site for the new plant, Victoria Ave. N., was obtained on Feb. 15th, 1918. It comprised just over three acres and had some old buildings on it that had formerly been occupied by the Dominion Soap Works. Secord & Sons of Brantford had the contract for the concrete and brick work, and the company's employees did most of the other work under the supervision of Mr. C. A. Mayer, who is in charge of the Hamilton branch of Imperial Co. Much credit is due to all connected with the construction work for the excellent progress made, the new plant being nearly complete eight months after construction began.

The new plant consists of the main offices and warehouse building, outside storage tanks, garage and shop, wagon shed, barn, boiler house and auxiliary filling tanks. The main building is about 50 ft. x 206 ft., and is of brick and reinforced concrete construction throughout. It is absolutely fireproof. The building consists of two stories and a basement. One end is occupied by the lubricating oil tanks; the offices are on the first floor at the south end of the building. The remainder of the building is devoted to the storage of specialties, package goods and all types of oil-burning and oil and fuel handling devices.

There are three big outside tanks, one for fuel oil with a capacity of 55,000 barrels, one for gasoline with



a capacity of 35,000 barrels, and one for refined oil with a capacity of 20,000 barrels. A battery of ten tanks in the main building provide storage for 2,400 barrels of lubricating-oil.

The garage is also of brick and reinforced concrete construction; it provides storage for twelve cars and trucks. Attached is a paint-shop and work-shop, which are thoroughly modern in appointments and equipment. The barn is of brick, and provides shelter for fourteen horses. Nearby is the wagon shed of steel in which twelve wagons may be stored. The boiler house is of brick and concrete construction. It contains two 25 horse-power boilers which provide steam for the steam heating coils in the lubricating oil storage rooms as well as for the remainder of the plant. Below the auxiliary filling tanks is a wash-room for the male employees of the plant.

Four eight-inch pipe lines provide communication with the dock, about a quarter of a mile away, where the tank steamers are moored for unloading. This provides for very rapid unloading, as 450,000 gallons can be pumped through one of the lines in twelve hours. Railway cars may be filled directly from the tanks and shipped to local consumers, or to any part of the Western Ontario sales territory, which is largely served from this plant. During the late fall, just before the close of navigation, the tanks are filled and sealed, so that the supply may be used in case of bad storms or any railway tie-up during the winter. After navigation has closed and while the weather is open for satisfactory traffic, tank-cars are used direct from the points of supply. This method applies to fuel oil, gasoline and refined oil, though the largest amount will be fuel oil. Lubricating oils are brought in by tank-cars. Distirbution of most of the products in the city, with the exception of large shipments of fuel oil, are made by tank-wagon. During the past autumn, after the completion of the plant, ten boats were unloaded here, each carrying about 450,000 gallons of oil.

AT THE COUGHLAN SHIPYARD.

The Coughlan Shipyard will lay the first keel on the contract for the building of four 8,100 ton steel steamers in about one months time. The first ways will be laid in about two weeks, and work will be rushed as rapidly as possible, states Mr. J. J. Coughlan. This yard is expected to build the first steel steamer for the Canadian Government to be built on the Pacific Coast. Previous steel vessels built here have been for the British or Nerwegian interests. These vessels will be named with the word Canadian as a prefix, such as "Canadian Voyageur," and "Canadian Pioneer," etc., instead of the "War" prefix, as previously used. Steel for these ships is on the way, and should be in Vancouver in a few days.

MONTREAL METALLURGICAL ASSOCIATION.

Minutes of regular meeting of the Montreal Metallurgical Association, held in the Macdonald Chemistry Building, McGill University, at 8.30 p.m., February 11th, 1919.

There were present forty-three members with the President in the chair. The minutes of the previous meeting were read and adopted.

Dr. A. Stansfield introduced Dr. A. W. G. Wilson, of the Mines Branch, Ottawa, who delivered an address on "Potash Recovery at Cement Plants." The information which was the basis of the lecture was gathered in the interest of the War Trade Board in August and December of lost year. The speaker on his visits to various cement plants in the United States was accompanied by Mr. Barre, Chemist, Canada Cement Co.

The lecture was reported verbatim, and will be published. It was also illustrated by numerous lantern slides.

In answer to a question from a member, Dr. Wilson stated that feldspar was not yet a factor in supplying potash, although chemically potash could be very easily recovered from feldspar, but no commercial methods had been successfully developed. He also stated that recovery from blast furnace gases was as yet in the experimental stage.

A vote of thanks was moved by Mr. Roast and tendered to the speaker. Secretary, R. J. Ross; President, A. Stansfield.

GETTING READY FOR LARGER BUSINESS.

On every hand there is evidence of faith in a revival in business, and new companies and firms are being formed to participate in this larger commerce. One of the new companies recently formed is the Imperial Trading Company, with head offices at the Herald Building, Montreal.

This company intends to deal in iron, steel, copper, brass, lead, spelter and other metals; in rails, railway equipment; motors, generators, transformers, and machine shop tools; wool felt, cotton waste and other textile products; also pulp mill and mining machinery.

The company is also negotiating for a number of

Major G. E. A. Bury.

E. C. Peterson.

sole agencies for Canada, of important products from the Orient, including China, Japan, East Indies, Malay States, Ceylon, Indo-China, Straits Settlements, etc.

The president is Major G. A. E. Bury, son of Sir George Bury. Major Bury, before joining the overseas forces, was a prominent barrister in Winnipeg. He returned to Canada recently, after over three years with the Canadian Expeditionary Force. He is a graduate of the University of Manitoba.

The Vice-President and General Manager is Mr. E. C. Peterson, formerly District Manager of the Northern Electric Company, Limited. Prior to that he was in charge of the Production Department of the Western Electric Company, Chicago, with which he began his business career in September, 1899, immediately after graduating from the Iowa State College, receiving the B.Sc. degree, both in mechanical and electrical engineering.

SHIPYARDS REDUCE WORKING FORCE.

The Wallace steel yards of North Vancouver had 1,200 men a few months ago, but this number is much below that at the present time, and a reduction at the rate of about 50 men per week until the force is reduced to a sufficient number to meet the ordinary demands of the yards will continue unless new contracts are received.

At the Lyall yards in North Vancouver, the working force fluctuates, and the conditions are uncertain for the next two months at least.

At the Northern Construction Company on False Creek, Vancouver, they are reducing their men gradually, and they figure that they will be completely finished at this yard in the next six or eight months unless they secure new orders.

These last two yards mentioned have built nothing but wooden ships.

EDITORIAL

CANADIAN MINING INSTITUTE.

We print in this number an open letter from Mr. D. H. McDougall, the new President of the Institute, with regard to the proposal to mark the enlarging scope of this Association by including in its title the word Metallurgy or Metallurgical.

The proposal was discussed at the annual meeting last month, and although it was received more favourably than last year, there was still a serious body of opposition to the change.

The objections that were raised were practically three in number:

(1) That the proposed name, "Canadian Institute of Mining and Metallurgy," is longer and more cumbrous than the present one.

(2) That changes of name are in general undesirable and that the older members are sentimentally attached to the old name.

(3) That the word mining includes metallurgy and is therefore sufficient in itself.

We are ready to admit the first of these objections. We have always recognized that the words Metallurgy and Metallurgical are cumbrous, difficult to pronounce and still worse to define and that Metallurgists are thereby placed at a serious disadvantage in comparison with their mining confreres. Metallurgists have, however, tried to bear up under the weight of their professional title, and if the Mining Institute is to become, as it should, more metallurgical in character and in membership, the metallurgists do not think it unreasonable to expect the mining members to accept the additional name.

Changes of name are certainly inconvenient, although a large number of individuals change their names at least once in their lifetime and profess sentimental reasons for so doing. Against the attachment of the mining members for the old name of the Institute there must be considered the possibly equally sentimental desire of the metallurgical members to have some share in the title of the Institute.

All these considerations would perhaps fall to the ground if it could be shown that mining really includes metallurgy, as the mining members allege. But does it? Would any of the mining profession admit, for example, that a foundry metallurgist, who had never in his life been down a mine, was a mining engineer? Until they are willing to do this we believe that metallurgists will maintain that metallurgy is a separate profession and will be suspicious of attempts to belittle it by including it in the term mining.

If we were to urge as an argument in favour of the change, that the English and American Societies have already led the way, we might only create a feeling of opposition on the grounds of Canadian independence. We believe however, that the reasons which led to the changes in the English and American Institutes are significant in regard to the industrial state of these countries. Until recently Canada has been a provider of raw materials which have been worked up in these more advanced countries. Consequently, in Canada Mining has been important and Metallurgy has been unimportant. In England, to take the other extreme, the metal mines are becoming exhausted, and the well developed metallurgical industries are depending to an increasing extent upon ores and half treated products from abroad. In England the metallurgical societies predominate. There is the Iron and Steel Institute, the Institute of Metals, and the Institution of Mining and Metallurgy. With the advance in industrial conditions in Canada, which has already begun to make headway, there is need of a Metallurgical Association. It seems desirable, in view of our limited population, to keep this Association as a part of the Mining Institute, and the change of name will assist in promoting this union.

HEAT TREATMENT OF SHELLS.

In our report of a meeting of the Montreal Metallurgical Association, page 46 of our March issue, a member is quoted as saying that at the Lymburner plant "no distinction in regard to the amount of carbon was made in the heat treatment, but only in annealing". We are in receipt from a letter of Mr. A. C. Attendu, metallurgical engineer of Lymburner, Ltd., Montreal in which he points out that the statement is incorrect as his practice, during the last 9 months of operation, was to group the shells into three classes, in accordance with their carbon content, and to heat each class to a particular temperature before quenching, and to another particular temperature when drawing the temper.

We endeavour, as far as possible, to print correct reports of the discussion at these meetings, but we do not hold ourselves responsible, in any way for the opinions expressed. When, as now appears to be the case, a mistake has been made either through the ignorance of the operator or in the reporting of his remarks, we are very glad to be corrected. Mr. Attendu sends us an interesting account of the methods employed at his plant, which we hope to print next month.

Mr. C. F. Herington, the author of the paper on "Pulverized Coal" published in this issue has fallen into an error when he states that the open-hearth furnaces, at Messrs. Armstrong Whitworth's plant at Longueuil, are operated with powdered coal as a fuel. It is true the installation was made but beyond a few experimental trial runs on one furnace nothing but oil fuel has been used at this plant for steel smelting.

PROPOSED CHANGE OF NAME OF CANADIAN MINING INSTITUTE.

(Reprinted with permission from Bulletin of The Canadian Mining Institute.)

New Glasgow, Nova Scotia,
22nd March, 1919.

H. Mortimer Lamb, Esq.,
Secretary, Canadian Mining Institute,
Montreal.

Dear Mr. Lamb:

Proposal to Change the Name of the Institute.

I believe it is proper, as a member of the Institute merely, that I should endorse Prof. Stansfield's proposal that the name of the Institute should be changed to the "Canadian Institute of Mining and Metallurgy."

For some time it has been a friendly gird of the metallurgical men in the Institute that our Transactions did not contain many papers of interest to the metallurgist, and as a result of a desire to keep the metallurgical men as active and interested members of the Institute, it was decided last year to form a Metallurgical Section, which was very successfully launched, and has gained general approval.

The urgency of the work in which the metallurgists have been engaged has prevented the Section from attaining its full usefulness, but the papers and discussions thereon in the Metallurgical Section during the Annual Meeting recently held, and the comparatively large attendance at its sessions, were encouraging indications that the Council of the Institute was well-guided when it arranged for the formation of the Section last year.

The change of name—perhaps it would be more accurate to call it the enlargement of the name of the Institute, is a natural consequence of the formation of the Metallurgical Section, but its chief claim for favorable consideration by the members is that it is in accord with the declared aim of the Institute to completely and thoroughly represent the mining industry in Canada.

The iron and steel industry of Canada, according to the census of the Dominion Bureau of Statistics taken in 1917, represents a capital investment of $651,786,805 out of a total capital invested in all Canadian industrial plants of $2,772,517,780, and it leads all other industries.

The importance, the dominance, even of metallurgical processes in connection with our mining industry, does not need to be explained to members of the Institute.

The Institute would be one-sided and incomplete without the metallurgist. It is not a convincing argument to say that the word "mining" includes the work of the metallurgist. It may—it possibly does—from the standpoint of the miner, but if the metallurgist thinks it does not, and if we wish to retain and strengthen the interest of the metallurgist in the Institute, we must recognize his point of view and enlarge our title so as to make it quite clear to him that he is very welcome.

Yours truly,
D. H. McDOUGALL.

We have received a copy of the new catalogue recently issued by the Scientific Materials Coy of Pittsburg. The book contains upwards of 600 pages, and gives illustrated details of the equipment necessary for chemical, metallurgical, and biological laboratories. Current prices are given, which although liable to market fluctuations, enable the purchaser to form a close estimate as to the cost of instruments and apparatus. The catalogue is arranged alphabetically and includes a comprehensive list of chemicals. This is the first trade publication we have seen from which all enemy products have been eliminated, and we can strongly recommend it as a useful book of reference, which should be on the shelf of every up-to-date laboratory.

IRON AND STEEL BY HUGH P. TIEMANN, B.S., A.M.

The Second Edition of this book has just been published by the McGraw-Hill Book Company, Inc. It contains 514 pages, 7 in. x 4 in., and 66 illustrations. The price is $4.00 net.

This is a carefully written, well printed and nicely
There is no table of contents or index. but the whole
There is no table of contents or index, but the whole book, except for a short introductory chapter, is arranged alphabetically like a dictionary or encyclopedia. Definitions are given for several thousand technical terms, and extended accounts are given of many of them. The subject matter includes the practical methods of iron and steel making, heat treatment and mechanical operations such as rolling and forging. It also contains very satisfactory accounts of the scientific theory and methods of metallography and allied subjects. In this edition the work has been brought up-to-date, and is as complete as is practicable within the limits of a pocket-book. We can confidently recommend it to all who are interested in the subject.

A good idea of the scope and purpose of this book can be gained from the introduction by Professor H. M. Howe, which we print herewith:

"It is with gratitude as a reader, pride as a teacher, and pleasure as a friend that I write a word of introduction to this admirable work of my former pupil and long-time friend, the Author."

The jargon of the millman, like that of the philosopher, is a deplorable necessity. It is a collection of invaluable special tools for special men doing special work. When the dentist and the obstetrician regard the unfathomable mysteries of each other's "kits," each has the consolation that he need not attempt the fathoming. But, alas, you and I cannot thus escape each other's jargon, for the metallographist must needs learn from the millman and the millman from the metallographist, and each has become the slave of his own tools, his own jargon. He talks and perhaps thinks in terms of it, if indeed we think in any language, which I doubt. At least, if he thinks in any language it is in his jargon. Life is too short, patience too flimsy, to permit our forcing out thoughts into others' minds by means of any tools other than our own jargon. The Author gives me an admirable case in point.

Foreman: "How does this steel work?"

Heater: "If you don't wash it, it won't clean."

This is "short hand" for: "The iron oxide or 'scale' which forms on the surface of this steel adheres so firmly that, unless it is heated so highly that it melts, some of it will cleave to the metal during the operation of rolling, and hence will deface the finished plates into which the steel is to be rolled." The heater's words are

not English; they are jargon, and it is proper that they should be. If he persisted in translating them into English as I have done, and in talking English in general, he would simply justify the dismissal which would surely come. The guild has evolved its jargon for its own use. To replace it with the King's English would be about as unwise as to replace it with French or modern Greek, or to replace "short hand" with "long hand" in the reporting of debate.

When the metallographist and millman meet, it is as the meeting of French and Greek. The millman scolds the metallographist; yes, and I have had to endure with my scanty patience many such scoldings for deliberately inventing jargon, useful for the metallographic guild, but a stumbling block to the millman. Of course, it is not I but the nature of things that ought to be scolded; but then it is pleasanter and less transparently foolish to scold me, especially if I have previously earned your gratitude by disentangling some of your fallacies and sophisms.

Now here comes the gallant Author to the aid of fumbling metallographist and irritated millman. With infinite pains, ingenuity and skill he blesses both, where they had baned each other, and enables the brothers to dwell together in harmony, unfolding to each the jargon of the other by means of a tri-lingual dictionary, translating the jargons of both into the common language, English.

Nor are they alone his debtors. Having long lived a metallographist and a teacher among the millmen, he discloses clearly, tersely and graphically the manners and customs of the millmen, to wit the how and the why of their actual practice, as only a resident can know it. In short, he describes the actual metallurgical operations and apparatus in a way which seems to me most admirable.

I commend the book without reserve to the whole family of steel metallurgists, be they millmen, metallographists, teachers, or students.

OBITUARY.

Richard Alexander Hogges, for a long time associated in a prominent way with the Steel Company of Canada, died of pneumonia following a brief illness. He was born in Dumfries, Scotland, in 1886, and received his rudimentary education at Glasgow. He began his business activities with A. R. Brown, McFarlane and Company, iron and steel merchants of Glasgow, and remained with them two years. At the end of that period he went with the Lanarkshire Steel Company of Motherwell and was in the head office of the company at Glasgow, where he occupied the position of chief clerk.

In 1910 he came to Canada and worked with Messrs. Hugh Russel and Sons and remained with them until he entered the employ of the Steel Company of Canada. He started as clerk in the work's office, and finally became the purchasing agent of the company. He is survived by his widow, who was Miss Jean McDonald Menzies, of Glasgow, and two children. His father, George Alexander Hogges of Glasgow, also survives him.

He was a member of the Royal Edward Lodge, A.F. and A.M. of Glasgow, and a member of the Knox Crescent Presbyterian Church of Montreal. The funeral was held from his late residence, 1260 Jeanne Mance street.

Electric Smelting of Iron Ores in British Columbia

By ALFRED STANSFIELD,

British Columbia Department of Mines, Bulletin No. 2, 1919.

(*Continued from March Number.*)

APPENDIX III.

Magnetic Concentration of Iron Ores.

In smelting low-grade ores of iron, it is sometimes economical to dress the ore before smelting it, in order to eliminate most of the barren rock-matter, and thus to reduce the cost of the smelting operation. This preliminary dressing is particularly desirable in the electric smelting of iron ores, on account of the small size of the furnace and the high cost of the smelting operation. Magnetite ores of iron are readily concentrated by means of an electric magnet which picks out the magnetite mineral and leaves the rock. It is necessary, however, to crush the ore sufficiently fine to separate the grains of magnetite from the grains of rock, and the concentrate must therefore be briquetted, or sintered into lumps, to make it fit for the smelting operation.

In the case of an ore containing 50 or 55 per cent of iron, and costing $4 per ton delivered to the furnace, it would scarcely pay to concentrate, obtaining a product of 65 to 70 per cent of iron, because the extra cost of the ore (as some is lost in the tailing) and the cost of the operation would about equal the economies to be gained in the smelting. If, however, by mining the ore in a more wholesale manner the cost of mining can be considerably reduced, and if the dressing operation is carried on at the mine or loading-wharf, so that the freight is only charged on the concentrated ore, there is a possibility of obtaining a smelting concentrate at a moderate price.

We may assume, for example, that the ore can be mined to contain 40 per cent of iron at a cost of $1 per ton, where the 50-per-cent ore cost $2 to mine. Adding the fixed charge of 10 cents and the royalty of 40 cents (50 cents for a 50-per-cent ore), the crude ore will cost $1.50 per ton. The crushing to 80 mesh and magnetic concentration may cost 80 cents per ton, making a total of $2.30. Suppose that 2 tons of ore yield 1 ton of a 70-per-cent concentrate, then the cost will be $4.60 per ton of concentrate. To this we must add a charge of, say, $1 for sintering and $1 for freight, making a total of $6.60 per ton. This corresponds to $9.45 per ton of pig-iron, which is $1.45 more than the cost using raw 50-per-cent ore at $4 a ton. The saving in the smelting process, due to the use of a richer ore, would be in the order of $3 a ton of iron, thus making a saving of about $1.55 per ton. The items of cost mentioned above have been made higher than usual on account of the increased cost of labour and supplies at the present time.*

Messrs. Beckman and Linden in their report (Appendix XI.) claim a net saving of $3 a ton of iron by dressing a 50-per-cent ore up to 65 per cent of iron. They consider the 65-per-cent ore to cost: 1.3 tons of ore at $4 = $5.20, and cost of crushing, dressing, and sintering, $1.25 per ton of concentrate, or a total of $6.45 per ton, or $9.43 per ton of iron. In view of the loss of iron in the tailings, they would probably need about 1.5 tons of ore, costing $6, while the crushing, dressing, and sin-

*These figures refer to a short ton of iron instead of a long ton, but as the discussion is comparative no serious error has thus been introduced.

tering will cost, at present rates, about $2, making a cost of $8 per ton of concentrate, or $12.30 per ton of iron. This is an increase of $4.30 over the cost of using the raw ore, and the saving in the furnace operation will be $2 or $3. Messrs. Beckman and Linden find a gross saving of $4.79, but I believe this is an over-estimate. In any case, even allowing for some error in my own estimate, it appears that no material advantage would be gained by dressing a 50-per-cent ore to obtain one of 65 per cent.

In the Swedish practice a moderate proportion, perhaps 25 per cent of concentrated ore, "slig," is used unbriquetted in admixture with lump ore, but finely crushed concentrates cannot be used to any great extent in the charge. If the preliminary reduction process (Appendix XII.) is found to be practicable, the ore will have to be crushed, and magnetic dressing will form an essential part of the scheme. The metallized powder can be melted without briquetting, because it will be, largely, a simple melting operation and there will not be a great production of gas in the furnace.

APPENDIX IV.

Electric Power for Smelting.

The possibility of the commercial operation of an electric-smelting plant for the production of pig-iron from iron ore depends on an adequate supply of electric power at a moderate rate. For the electric smelting of iron ores a large amount of power is needed, the amount varying somewhat with the richness of the ore, the grade of iron to be produced, and the kind of furnace employed. Under usual conditions the consumption of electrical power for each long ton of pig-iron lies between one-third and one-half of a horse-power year. For the production of foundry iron from rather low grade ores, and in a simple pit furnace, it will not be safe to count on the production of more than two long tons of iron per annum for each electric horse-power supplied to the works. For a production of 50 tons of pig-iron daily some 8,000 or 9,000 electric horse-power will be needed, and if provision is made for the production of ferro-alloys and the making of steel in electric furnaces, some 10,000 to 15,000 horse-power must be provided.

It was recognized that such a supply could be obtained by developing certain water-powers on Vancouver island or on the mainland, but in view of the need of establishing the smelting industry at the earliest possible date, and of the extreme difficulty and expense of new development-work under present conditions, it was decided, if possible, to use power that was already developed for the initial operation of the plant, and to defer until later the development of fresh power for the permanent operation of the industry.

With this in view a letter was written from the Department of Mines to the general manager of each of the power companies of British Columbia, as follows:

June 4th, 1918.

Dear Sir,—Will you kindly furnish me at your very earliest convenience with the following information:—

Whether your company is in a position to supply electrical power, starting, say, at 15,000 electrical horse-power, in the hope of increasing the power within a few years up to 50,000 electrical horse-power.

At what point could you supply it?

The cost for the same, showing how the cost is estimated.

The voltage and frequency of the electric current.

The extent to which a constant supply can be depended on.

I desire to have this information in order to be prepared with the statistics requisite for a thorough investigation into the possibilities of establishing electric iron-furnaces in British Colmbia, which will be investigated by Dr. Alfred Stansfield, of Montreal, who is expected to arrive here on the 10th inst.

Yours faithfully.

The following replies were received:—

British Columbia Electric Railway Co., Ltd.,
Hastings and Carrall Streets,
Vancouver, B.C., June 10th, 1918.

The Hon. Wm. Sloan,
Minister of Mines,
Parliament Buildings, Victoria, B.C.

Power for Electric Furnaces.

Dear Sir,—With reference to your letter dated June 5th, enclosing questions regarding the power available from my company's plants for the operation of electric-smelting furnaces, the following data may assist Dr. Alfred Stansfield in his investigation of this subject:—

Our hydro-electric plants are now developed to supply a greater demand for power than exists at the present time, and a portion of this energy might be used for the operation of electric furnaces. You give no information regarding the load factor or power factor at which this energy could be taken, and the amount of power which we could supply necessarily depends on these factors. It is probable, however, that we could furnish 15,000 electric horse-power with the power-factor and load-factor conditions under which electric furnaces generally operate.

As regards increasing the supply of power from 15,000 horse-power to 50,000 horse-power during the next few years, our Coquitlam-Buntzen power scheme is now fully developed, and it would not be possible to install additional machinery at either of our Lake Buntzen plants. We have, however, in view other water-power schemes on which stream-flow data is now being obtained and which could be developed in the future as the need arises. It might also be possible for us to purchase an increasing amount of energy if the load conditions on our system warranted such action. My company is therefore in a particularly favourable position to supply the energy which would be required for a large power-load, subject to great expansion.

From the point of view of power-supply, an electric-furnace plant should be located, if possible, in close proximity to the power-house supplying energy for its operation.

Our water-power plants are located on the east shore of the North arm of Burrard inlet, about fourteen miles from the city of Vancouver. The North arm is almost entirely surrounded by high mountains which slope steeply to the water's edge, and there is therefore comparatively little level ground on which buildings or other structures could be erected. There is, however, a small piece of level ground, triangular in shape, and about ½ acre in extent, at the north end of our No. 1 Power-house, but whether this piece of ground would be sufficiently large I do not know. The advantages of locating the electric-furnace plant adjacent to our power-house may be summarized as follows:—

(1.) Power could be supplied from the power-house bus-bars at 2,300 volts, or possibly at a slightly higher

voltage. The use of transformers to step up to a voltage suitable for transmission would thus be avoided, and the construction of additional transmission-lines would be unnecessary. If power were taken at any point on our existing transmission-lines, the voltage would be approximately 34,600.

(2.) Two or more of our generating units could be set aside to supply the furnaces, and this load could therefore be entirely independent of our transmission system. In order to make a similar arrangement for any other location of the furnace plant, the construction of a separate transmission-line from the power-house to the furnaces would be necessary. The remainder of our system would have obvious advantages, both from the standpoint of the consumer and of the power company.

(3.) A substantial concrete wharf equipped with a power-operated derrick is available at No. 1 Power-house. There is sufficient depth of water at this wharf to allow large scows and steamers of fair size to tie up.

(4.) An abundant supply of pure fresh water at a low temperature and at a pressure of approximately 175 lb. per square inch is available at Power-house No. 1.

On account of the location of this plant, the air is clean and contains fewer impurities than would be found in air nearer the city.

If the location at the north end of Power-house No. 1 does not provide sufficient area, another site might be found about half a mile north of No. 1 Power-house. The construction of a plant at that point, however, would involve the building of a short piece of transmission-line over very rough country and the use of transformers, etc.

It is extremely difficult to reply by letter fully and satisfactorily to your questionnaire, but we shall be glad to go into this matter with Dr. Stansfield on his arrival in British Columbia should he desire to investigate the capacity of our plants.

Yours faithfully,

(Signed.) GEORGE KIDD,

General Manager.

Hon. Wm. Sloan,

Minister of Mines, Victoria, B.C.

Dear Sir,—I have your communication of June 5th, asking for information in respect to the possibility of a considerable power-supply for electric iron-furnaces, and I must apologize for delay in making answer.

Western Power Company of Canada, Limited, has now in operation in its plant at Stave Falls three 13,000-horse-power units capable of supplying a maximum demand of about 25,000 kilowatts. Of this power the British Columbia Electric Railway Company may demand 15,000 kilowatts, and the balance is nearly all taken up by the company's other customers.

The company has the greater part of the machinery on hand for the installation of the fourth 13,000-horse-power unit, which can be installed when necessary at a comparatively small cost. The turbine for this unit is, however, at the factory in Zurich, Switzerland, where it was built, and there is some question as to when it could be shipped. If this unit were installed, Western Power Company of Canada, Limited, would be in a position to sell 7,000 to 9,000 kilowatts more than at present.

The company has a second site lower down on the Stave river which, if developed in conjunction with the existing plant, could be built very economically, and from this site there could be produced about 40,000 horse-power continuously.

There is nothing in the development of this lower site which would cause the construction to take longer than usual for this class of work.

Power could be delivered from either of these plants at any point between Stave Falls and Vancouver. The most economical point of delivery, so far as power is concerned, would, however, be at Ruskin, which is close to the power-site. In some ways Ruskin would be an advantageous spot for the establishment of an iron-smelter, but if a point on or near Burrard inlet were selected the transmission-line would not be more than twenty-five miles long.

With the above-mentioned developments a very reliable and constant supply of power could be depended upon, for the power plant has a storage-reservoir twenty-four square miles in area and 25 feet deep; besides, the large snow-field and glaciers which feed the Stave river tend to give great regularity in the annual flow, and no trouble of any kind is experienced in operating the plant in winter on account of ice.

The electric current supplied by Western Power Company of Canada, Limited, is of frequency 60 cycles and can be supplied at 60,000 or 12,000 volts. The company has just connected up a 6-ton electric furnace, which has been installed at the works of the Aetna furnace, which is now producing pig-iron from scrap, Iron and Steel Company, at Port Moody, and this is operating very satisfactorily on the 60-cycle current.

For the supply of electric power for smelting iron ores the question of the "cost of power" is more difficult than the question of "quantity of supply." All the plants in the neighborhood of Vancouver have been designed and built for the supply of general power business, and it is a question whether the electric-smelting furnace could pay a price for the power that would be remunerative to the power companies.

For smelting steel the quantity required per ton of product is such that the steel-makers can pay rates which, though low, are remunerative to the power companies. The amount of power required per ton of iron produced from the ore is, however, so much greater than that required for merely melting iron or steel that the price of power for smelting would have to be very low, and it is difficult to see how a price that would have to be secured for smelting would be remunerative to the British Columbia Electric Railway Company.

Western Power Company of Canada, Limited, is selling power to the British Columbia Electric Railway Company at a price which is equal to three mills per kilowatt-hour, and while it would be impossible for the company to sell more power at this low price, it might be possible to do something in co-operation with the British Columbia Electric Railway Company.

It is difficult to present the whole situation in a letter, but the financial organization of Western Power Company of Canada, Limited, is very simple, and its costs are shown very clearly upon its books and monthly statements, so that it would be an easy matter to show Dr. Stansfield exactly how the situation stands. I would very much like to have the opportunity of explaining our costs and possibilities in an interview, either with yourself or with Dr. Stansfield,

as my company is interested in doing everything possible to establish the industry of electric smelting, and any information which we have will be at your disposal.

I am, dear Sir,

Yours very truly,

Western Power Company of Canada, Limited,

(Signed) R. F. HAYWARD,

General Manager.

Canadian Collieries (Dunsmuir), Limited,

Victoria, B.C., June 21st, 1918.

Hon. Wm. Sloan,

Minister of Mines, Victoria, B.C.

Dear Sir,—Replying to your letter of June re information required re electric iron-smelting inquiry:

In reply to your question No. 1, we have developed on the Puntledge river about 10,000 horsepower, composed of two units of 5,000 horse-power each. One unit is about working to its capacity, the second being kept in reserve. We would not be able to supply anything like the power you mention without adding further units. The plant is partly developed for another 10,000 horse-power, which would be the total capacity of the plant owing to the volume of water that can be taken out of Comox lake.

I would be glad some time at your convenience to discuss the power situation with you with a view to any iron-development taking over the power plant as a whole and our installing individual steam plants at each mine.

Yours truly,

(Signed.) J. M. SAVAGE,

General Manager.

The West Kootenay Power and Light Co., Ltd.,

Rossland, B.C., June 13th, 1918.

Hon. Wm. Sloan,

Minister of Mines, Victoria, B.C.

Dear Mr. Sloan,—I beg to acknowledge receipt of yours of the 7th re power-supply for electric furnaces.

At present our developed power is all contracted for, and to supply 15,000 horse-power it would be necessary to extend our hydro-electric plant at Bonnington, and for your information would state that we would be able to supply up to 50,000 horse-power.

It will take some time to prepare an estimate as to the cost of developing the power required, and before starting on this I would be very pleased to meet Dr. Alfred Stansfield in order to get further information. In other words, if it so worked out that power could be used at the point of development, then we would be in a position to quote a lower price than if we were called upon to transmit at any distance, and it appears to me that if you could arrange a meeting it would place me in a very much better position to comply with your request.

Yours very truly,

West Kootenay Power and Light Co., Ltd.,

(Signed.) L. C. CAMPBELL,

General Manager.

During my visit to British Columbia I had interviews on this subject with Mr. George Kidd and other officials of the British Columbia Electric Railway Company; with Mr. R. F. Hayward, General Manager of the Western Power Company; and with Mr. J. M. Savage, General Manager of the Canadian Collieries, Limited. In view of the necessity of locating the proposed plant on or near tide-water, it was not worth while to discuss the possibility of obtaining power from the West Kootenay Power Company.

The information obtained verbally from the above-mentioned officials was substantially as follows:—

The Western Power Company have some unused electric power, but this has been contracted to the British Columbia Electric Railway Company. If this contract could be set aside, the former company might be able to supply as much as 15,000 horse-power, at a rate of, say, \$15, for a few years until it was needed for better-paying purposes. On the other hand, the British Columbia Electric Railway Company might be willing themselves to resell this block of power for electric smelting. Although the development expenses of these companies have undoubtedly been high, they could apparently make a reasonable profit by the sale of power at \$15. As, however, their usual sale prices is not less than \$25, it would not pay them to tie up power at \$15 which they might be able in a year or two to sell at \$25. This argument would not hold in normal times, because they could develop some of their reserve power to supply the growing market; but at the present time it is very undesirable to have to undertake any fresh development, and the power companies naturally wish to sell their developed power to the best advantage.

It may be noted that \$25 a horse-power year probably refers to an 80-per-cent load factor, under which conditions the cost is substantially 0.5 cent per kilowatt-hour. Under regular working conditions an electric-smelting plant should use about 90 per cent of its maximum load, and \$25 power would then cost about 0.43 cent per kilowatt-hour, or, conversely, 0.5-cent power would represent nearly \$30 a horse-power year.

The British Columbia Electric Railway Company have some unused power on Vancouver island, but the amount is less than they have on the mainland, and the supply on the island is less dependable owing to the danger of dry seasons.

The Canadian Collieries, Limited, have a water-power on the Puntledge river of which 10,000 horse-power has already been developed and a further 10,000 horse-power is available for development. Of the 10,000 horse-power now developed, some 5,000 horse-power is employed at the mines, leaving only 5,000 horse-power unused. The management are considering the use of steam-power at the mines in place of electrical power on account of its greater reliability and its small cost, using coal from the mine. It is therefore possible that, if they could obtain a market for the 10,000 horse-power now developed, they might decide to make the above change. I have at present no information with regard to the price at which they would be willing to sell this power. Such an arrangement would aford an immediate supply of 10,000 horse-power, and an additional 10,000 horse- power when development-work again becomes possible.

As it appeared that the surplus developed power of the Western Power Company was controlled by the British Columbia Electric Railway Company, I discussed the situation fully with Mr. George Kidd, of the latter company, and wrote him the following letter:—

Vancouver, B.C., June 18th, 1918.

Dear Mr. Kidd,—I have been appointed, as you are aware, by the Provincial Government to obtain information in regard to the commercial possibility of smelting the magnetite ores of British Columbia by means of electrical power, and for this purpose I should be

greatly obliged if you could furnish me with information with regard to the amount and cost of electrical power which it would be possible for your company to place at the disposal of any firm undertaking such operations.

In the smelting of iron ore by electrical energy, the amount of power needed per ton of pig-iron is somewhat high, being in the order of 0.4 electrical-horse-power year, and it is therefore necessary, in order to produce pig-iron commercially, that the cost of this power shall be as low as possible, and shall be considerably below the prices at which such power is sold for mechanical use.

Speaking from memory, the cost of power in Sweden, which is the only locality in which the electric smelting of iron ores has become a commercial fact, is below $10 per electrical-horse-power year, but it seems reasonable to suppose that in this Province, in view of the higher price of pig-iron and supplies generally, a somewhat higher figure would not be out of the question, say as high as $15 per horse-power year. I understand that you could not offer a figure so low as that under ordinary commercial conditions, but only by some special arrangement, as surplus power which you would not guarantee to supply far ony definite length of time.

My impression with regard to the development of such a project would be that a furnace using perhaps 2,000 kw. would first be installed, and that after the experimental stage larger furnaces would be put in so as to use 5,000 or 6,000 horse-power, with the expectation of increasing the consumption to about 10,000 horse-power, or possibly as much as 15,000 horse-power. At the latter figure the production of pig-iron would be about 100 tons per day, which is I believe, as much as would be needed in the near future in this locality.

For the commercial smelting of iron ores electrically it will undoubtedly be desirable to locate the plant ultimately at some point remote from a large city, where the power could be developed specially for this purpose at the cheapest rate and without any cost for transmission. In view, however, of the fact that the electric smelting of iron ore has not reached its final condition in regard to details of furnace-construction, and possibly even in more fundamental respects, it seems undesirable in the start to undertake a new development of power for this purpose, and the more satisfactory method appears to be to obtain power from your own or other developed system for a period of, say, four or five years, with the intention of obtaining a fresh source of power and rebuilding the plant at the end of that period.

With respect to the details of the supply, I may say that the load factor for electric iron-smelting purposes has been very satisfactory, and would probably be as high as 90 per cent after the initial difficulties of a new plant had been overcome. I have no definite information with respect to the possibility of modifying the demand so as to avoid the peak-load of a distributing system, but in my opinion this would be possible, so that, for example, if the furnaces were using 10,000 horse-power the draught could be reduced to perhaps two-thirds of this amount during three or four hours of the day during the peak-load. It would be possible, further, to run a larger number of furnaces during the winter months, when your water-supply was ample, than in the summer months, when there might be a shortage of water, but this would, of course, reduce the output from a given cost of electrical installation.

The power factor of these furnaces has been found to be very high in Sweden, where the supply is one of 25 cycles, but in California, using a 60-cycle supply, the power factor of the furnace has been found to vary from nearly unity when the furnace is empty to as low as 65 per cent when the furnace is ready for tapping. I should think, however, that if special attention were paid to this side of the design of furnace, it could be made to keep the power factor above 80 per cent at all times.

With respect to the voltage of the supply, I may point out that in these furnaces the regulation is effected by a series of taps on the primary of the service transformers, there being usually three such transformers for each furnace which are independently regulated. On account of this the transformers are of special design, and the primary voltage would not be more than about 10,000, and preferable in the order of 2,000.

With regard to the location of an electric-smelting plant, I cannot speak at all definitely, but as a basis for discussion it would be satisfactory for you to take the site at Port Moody, adjacent to the present electric-furnace plant.

Further, with regard to the date at which the use of power might be expected to commence, it will require a month or two for the completion of this report and for the Government to study it, after which, if action were decided on immediately, I understand that in view of the difficulty of obtaining electrical supplies it would be necessary to allow as long as twelve months for the construction of the plant, which would thus place the possible start of operations in the fall of 1919.

I believe that the above will give you the more essential facts with regard to the possible use of electric power for smelting iron ores. I expect in the course of a week or ten days to be back in Vancouver, and will then be able to give you further information in view of the conditions which I expect to find in California. I should be very glad if in the meantime you could draw up some memorandum which would give me information in regard to the price and amount of power which might be available for this purpose and any available particulars with regard to the conditions of the supply.

I remain, Yours very truly,

(Signed) ALFRED STANSFIELD.

In view of the fundamental importance of the information asked for, I was hoping to receive a reply before leaving British Columbia. On returning from California early in July, I found that no reply had been prepared, and that the street-railway strike would make it impossible for the company to supply the information in the near future. I was therefore obliged to prepare my report without any definite information in regard to the price at which power could be obtained. Under the circumstances, I made the provisional assumption that some 10,000 kw. of electrical power could be obtained at a cost of $15 per electrical-horse-power year of about 85 or 90 per cent load factor.

On September 19th, when my report was nearly completed, I received the following letter from Mr. George Kidd:—

British Columbia Electric Railway Co., Ltd.,
Vancouver, B.C., September 12th, 1918.

Dr. Alfred Stansfield,
Department of Metallurgy,
McGill University, Montreal.

Dear Sir:

Electric Smelting of Iron Ores.

With reference to your recent visit to this Province and in regard to the information then promised you respecting the supply of electric power available in the districts served by this company on the main-

land and Vancouver island for the purpose of smelting iron ores, I regret that there has been unavoidable delay in submitting this data at an earlier date.

Mainland (Vancouver and Districts). — Since our representatives discussed with you the power situation there has been a very considerable change in local conditions, caused by contracts having been entered into disposing of our excess electrical energy on a surplus-power basis. Any contracts entered into would not, therefore, have to be made on a commercial-rate basis.

We would be willing to enter into short-term contracts to furnish power from 2,000 to 10,000 kw. for restricted service during this company's peak-load periods from its water-power plants at a rate of 0.5 cent per kilowatt-hour, based on a power factor of 80 per cent. Should the average monthly power factor fall below 80 per cent., then this rate of 0.5 cent per kilowatt-hour would be increased in the ratio of 80 to the actual average monthly power factor at which the furnace is operated. The minimum charge would be 50 cents per month per connected horse-power, based on the full capacity of the furnace installation.

There are two sites on the east shore of Burrard inlet which may prove suitable for an electric iron-ore-smelting plant. One of these is at a distance of half a mile north of No. 1 Power-house; the other is about five miles south of No. 1 Power-house, in the vicinity of Bidwell bay. There is no data available regarding the areas of vacant land at these places, and it is impossible to say whether sufficient level ground could be obtained.

The site half a mile north of No. 1 Power-house would be most suitable from the power-supply standpoint, and would involve the construction of only half a mile of transmission-line.

The Port Moody location, referred to by you, would be satisfactory from a rail-transportation point of view, and by the time an electric-smelting plant would be ready for operation we would probably arrange to supply the necessary power at that point.

Vancouver Island (Victoria and District).—On Vancouver island we have at present an excess of power of about 2,000 kw. which we are prepared to dispose of on a surplus-power basis at $15 per electrical-horse-power year, in blocks of not less than 500 kw. and the power factor to be not less than 80 per cent. This figure is not a commercial rate, but an experimental rate, and could only be granted for a short-term contract, and, of course, subject to peak-load restrictions and depending upon the amount of storage-water which we may have available in our reservoirs during the dry season.

This amount of power could not be reserved, and would only be available after the filling of all requirements for electrical energy for the company's use and those of its present and future customers.

In respect to available sites on the island, there are several which may be found suitable. One at Jordan river, near our power plant; another at Brentwood, on the Saanich peninsula, adjacent to our steam auxiliary power plant. Other sites might be found at Sooke harbour or near Esquimault.

Covering both the mainland and island systems, 3-phase, 60-cycle, alternating current would be supplied at or near our existing transmission-lines, which are of sufficient capacity to supply the furnace plant; the transmission-line voltage would be 34,600 or 11,000, depending upon the location on the mainland, and 60,000 volts on the island.

I trust the above will generally cover the information desired, and should there be any further particulars needed we shall be very glad to supply same upon hearing from you in this matter.

General Manager.

Yours faithfully,

Signed. GEORGE KIDD.

Before leaving British Columbia I wrote the following letter, at present unanswered, with a view to obtaining further information about the supply of power from the Canadian Collieries, limited:—

Victoria, B.C., July 9th, 1918.

Honorable William Sloan,

Minister of Mines, Victoria, B.C.

Sir,—In the letter to yourself of June 21st from the Canadian Collieries with regard to power for electric smelting, Mr. Savage states that he might be willing to install steam plants at each of his mines and to turn over the whole of the hydro-electric power for the purpose of iron-smelting. This would apparently supply 10,000 horse-power already developed, with a further 10,000 horse-power now partly developed.

I should be glad to learn, for the purpose of my report, at about what price per horse-power year of 80 per cent. load factor he would be able to supply these blocks of 10,000 or 20,000 horse-power for the purpose of electric iron-smelting at a point on tide-water in Comox harbor or Baynes sound.

I regret that owing to Mr. Savage's absence from the city I have not been able to discuss these matters with him personally.

I have the honor to be,

Sir,

Your obedient servant,

(Signed.) ALFRED STANSFIELD.

With a view to the future development of the electric-smelting industry, I obtained information with regard to water-powers in British Columbia that could be developed for the purpose of electric smelting. In general, it appeared that there was ample power available, and that some of these powers could be developed so cheaply as to yield electric power for smelting purposes at about $10 per continuous horse-power year. Mr. H. K. Dutcher, of Vancouver, considered that the following powers could be developed at about that cost:—

	Horse-power.
Campbell river	100,000
Cheakamus river, Howe sound . . .	200,000
Stamp falls, Alberni	40,000

Mr. William Young, Comptroller of Water Rights, Victoria, gave me the following particulars with regard to the Campbell River and Stamp Falls power-sites:—

Memorandum re Campbell River Power-site.

The drainage area is approximately 520 square miles; no definite precipitation data are available, but the British Columbia Hydrometric Survey report a variation from 80 inches at the mouth to 130 inches at headwaters.

Gore & McGregor's second report proposes the erection of a dam at Irene pool, mean water-level at this place being 415 feet; the power-house to be situated on the canyon, with an assumed flood-level of 98 feet. The proposed elevation of the dam is 440 feet, giving a head of 342 feet.

A constant discharge of 2,700 c.f.s. is assumed, calculated to develop 78,000 to 80,000 horse-power, with another 6,000 horse-power by storage. This discharge is, however, too high, as the mean over six years is

2,650 c.f.s., with a minimum of 450 c.f.s., and one low-water period of nine weeks below 1,000 c.f.s. On the Strathcona survey map, tracing of part of which is attached, the level of Lower Campbell lake and McIvor lake is given as 543 feet.

Stamp Falls Development—Summary of Report by Ritchie-Agnew Power Co., Ltd.

Drainage area, 360 sq. miles.

Results of seven months' gaugings, continuous flow available, 2,394 cu.-sec. feet.

Estimated run-off square mile of drainage area, 6 cu.-sec. feet.

Estimated storage per square mile of drainage area from short mass diagram, 716 acre-feet.

Estimated mean annual run-of, 2,160 cu.-sec. feet.

Storage available on Great Central lake dam 20 feet high, 307,200 acre-feet, or 853 acre-feet per sq. mile of drainage area.

Pipe-lines, three 11 feet diameter and one 7 feet and 6 inches diameter, 600 feet long.

Maximum height, 90 feet.

Mean effective head, 110 feet.

Power available based on 60 per cent. load factor, 80 per cent. efficiency factor, 35,000 horse-power;

Proposed installation, three units, 10,000 horse-power; 5,600 kw.

Proposed installation, one unit, 5,000 horse-power; 3,000 kw.

Transmission-lines to Alberni, seven miles, 12,000 volts.

Transmission-lines to Nanaimo, sixty miles, 66,000 volts.

The Stamp Falls power is estimated at 35,000 horse-power on a basis of 60 per cent. load factor. As, however, an electric-smelting plant would operate at 85 per cent. or even 90 per cent. load factor, this will only correspond to about 24,000 horse-power or 18,000 kw. Such a power could be developed and utilized entirely for electric smelting. The plant could be located at or near Port Alberni, with a seven-mile transmission-line, and could obtain iron ores from the deposits around Barkley sound, from Nootka sound, and from the Renfrew district. An alternative plan would be to transmit the power about furteen miles to Deep bay, on the east coast of the island, where ores could be obtained readily from Texada island and Redonda island.

The Campbell River estimate indicates about 84,000 continuous horse-power, or 100,000 horse-power, at 84 per cent. load factor. This would be more than could be utilized for electric smelting in the near future, and it would be necessary to develop it for use in part by some other large consumer of electric power. An electric smelter placed on tide-water within a short distance of the proposed power-house would be supplied with ore very readily from Redonda island, and also from the deposits No. 4 and No. 5 in the Quinsam Lake district.

The water-power available on the Cheakamus river is estimated at 200,000 horse-power, which is twice as large as the Campbell River power, and would need development in conjunction with other power-users. It is not situated so conveniently with regard to the ore-supplies as the powers on Vancouver island, and it may ultimately be needed for the development of Vancouver City.

With regard to the general estimate that these water-powers would yield electric power for smelting at about $10 a continuous horse-power year, it will be understood that such development would be out of the question at the present time in view of the high cost of labor and supplies and the difficulty of obtaining apparatus. In view of the present unsettled state of labor, it is useless to try to predict how long it may be before these costs become low enough to permit of economic construction, or whether costs will ever again revert to pre-war levels. It seems probable, however, that within a few years after the termination of the war, wages and costs in general will arrive at some more settled condition; and even if these are twice as high as before the war, that will not prevent construction-work, as the price of commodities generally will also be much higher than before the war and will tend to assume a definite relationship to the enhanced cost of labor and supplies.

The bearing of this consideration on the electric smelting of iron ores in British Columbia may be stated as follows: Before the war with electric power at $10, and other costs as they were then, the cost of a ton of electric pig-iron, using the Swedish process, would be between $20 and $25, leaving only a small profit, as pig-iron was selling at $25, unless a higher price could have been obtained for electric pig-iron. If, after the war, prices were to settle down at double the pre-war figures, electric power would cost $20 and pig-iron would bring $50, while labor would be about as high as at present. The cost of making electric pig-iron might be about $45, leaving the same proportionate profit as before the war. The reason which makes electric pig-iron making profitable at the present time is the temporary dislocation of prices during which the cost of pig-iron and steel has risen more rapidly than the cost of power, labor, and other supplies.

In regard to the cost of power for electric smelting, it may be pointed out that in developing a power for this purpose the turbines and electrical machinery will cost less per kilowatt-hour utilized than in the case of a power plant for ordinary power-users. This is because the load from a smelting plant can be kept almost constant for twenty-four hours daily and 365 days in the year, whereas an ordinary plant has to supply a very varying load, and so the machinery is not used to the best advantage. It follows that electrical power for smelting purposes can be developed to cost considerably less per kilowatt-hour than when developed for ordinary use.

APPENDIX V.

The Supply of Carbonaceous Reducing Materials.

In the electric smelting of iron ores, carbonaceous material is needed for reducing the ore to the metallic state and for supplying carbon to the pig-iron. The amount needed varies from about 1/3 to ½ ton per ton of pig-iron produced. For this purpose either charcoal or coke may be used, but charcoal is preferable on account of its greater purity—that is, freedom from sulphur and ash—and because its physical condition renders it more suitable for electric-furnace operation. For the production of special grades of pig-iron charcoal would always be preferred, but for ordinary grades a good quality of coke, if obtainable at a low price, might be employed on account of its smaller cost. In British Columbia, however, nearly all the coals are abnormally high in sulphur and ash, and the cost of coke produced from them is so high that there is no inducement to use it instead of charcoal in a country

where timber is so abundant.. While, however, charcoal should be regarded as the normal supply of reducing carbon, coke can be used to some extent in admixture with charcoal as a substitute without seriously affecting the operation of the furnace, and it can be used in this way in case of shortage of charcoal.

There is at present no large-scale production of charcoal in British Columbia, and the small quantities now obtainable cost in the order of $30 a ton, a price which would be prohibitive for iron-smelting. The production of 20 or 30 tons of charcoal daily constitutes an important industry, utilizing 50 to 70 cords of mill-waste and yielding by-products that will meet a part of the cost of operation. The problems involved are many and complicated, and before discussing them in detail it may be stated: (1) That the mill-waste of Douglas fir should be suitable for the production of charcoal for electric smelting; (2) that while the lumber-mills in and near Vancouver utilize their waste very largely, there are mills situated at more remote points from which an adequate supply of waste could be obtained at a nominal cost; (3) that the by-products from this material are not so valuable as to make it desirable to treat the wood in retorts for the recovery of turpentine, etc., regarding the charcoal as a by-product, but that it should be possible to char the wood on a large scale for the production of charcoal and still to recover a part of the by-products; such a plant would be located at or near one or more sawmills, and the charwould be transported by water to the smelting plant; (4) if a charcoal industry were established in suitable relationship to the lumber industry, charcoal should be produced and delivered to the smelter at a cost of about $6 or $8 per ton, corresponding to $3 or $4 per long ton of pig-iron.

An electric iron-smelting industry in British Columbia will almost certainly use charcoal, wholly or in large part, for the reduction of the iron ore. The establishment on an economical basis of a charcoal-making industry will therefore be essential to the commercial production of electric pig-iron.

Methods of Charcoal-Making.

Charcoal is used in some parts of the world for the production of "charcoal-iron" in small blast-furnaces. In general, hard woods are preferred for making this charcoal, because the resulting charcoal is stronger and better able to stand the load in the furnace without crushing, and because hard woods yield more valuable by-products in their distillation, which meet to a considerable extent the cost of the operation.

For the electric smelting of iron ores the strength of the charcoal is less important, because the height of the shaft is less, even in the Swedish furnace, and because, unlike the blast-furnace, no blast of air need be forced through the charge, although in the Swedish furnace there is a circulation of the furnace gases.

In Sweden the charcoal for electric smelting (as well as for blast-furnaces) is made from soft wood, and the charcoal-making is carried on at numerous points throughout the country, using in part the waste wood from the lumbering industries.

E. Arosenius (International Institute of Agriculture, Rome, January, 1918) gives some particulars of the Swedish charcoal industry. He states that the raw materials used in Swedish sawmills are soft woods, mainly Scotch pine and spruce. He estimates as follows the production and uses of charcoal in Sweden during 1913:—

	Bushels.
Forest wood charred in ovens.....	8,000,000
Wood-waste charred in piles......	29,000,000
Wood-waste charred in ovens.....	1,300,000
Forest wood charred in piles (about)	75,500,000
Charcoal imported from Finland and Norway	3,300,000
Charcoal used in metallurgical works	117,300,000

For rough purposes we may assume a bushel of charcoal to weigh 20 lb., so that the consumption in Sweden must be over 1,000,000 tons. If this were all used in electric smelting it would represent a production of at least 2,000,000 tons of pig-iron. Actually, however, a large proportion is still employed in charcoal blast-furnaces and in the production of wrought iron, for which purposes the consumption of charcoal per ton of iron is much larger.

I have not been able, in the time available, to obtain full particulars of Swedish charcoal-making, but I would recommend that such information should be obtained before deciding on the methods to be used in British Columbia.

In the Coast districts of British Columbia the largest production of any variety of timber is the Douglas fir. In 1917 some 676,000,000 board-feet of this wood was cut in these districts. The Douglas fir appears to be suitable for the production of charcoal, and I have, for my own information, made a small amount of satisfactory charcoal from a sample of this wood.

Apart from the use of "piles," which we need scarcely consider, charcoal is made in "kilns," in "retorts," and in "ovens."

Kilns.—There are large brick structures holding as much as 50 cords of wood. The heat needed is furnished by the combustion, within the kiln, of part of the volatile products and a little of the charcoal itself. A part of the by-products can be recovered, the loss of charcoal is not very great, and this is probably the cheapest method of making charcoal in cases where the by-products are of secondary importance.

Retorts.—These are small, expensive to operate, and only warranted when large amounts of valuable by-products are obtainable.

Ovens.—These are large retorts. The wood to be charred is contained in cars which are run into the ovens, and after the operation the cars, which now contain the charcoal, are run out and placed in large steel boxes where they can cool out of contact with the air. The ovens are heated externally by means of waste wood and the distillation gases. Ovens give a maximum production of the volatile by-products and the charcoal, and are largely used for charring hard wood.

In the charring of hard woods, such as beech, birch, and maple, considerable amounts of valuable by-products are obtained. These are wood-alcohol, acetate of lime, and tar. At the present time the value of these products is greater than that of the charcoal, and it pays to treat such woods in ovens in order to obtain the by-products. The soft woods have different distillation products, and it does not always pay to char them in ovens. Some of these, such as the long-leaf pine, yield considerable amounts of turpentine, pine-oils, and tar, while the production of alcohol and acetic acid is usually too small to pay for their recovery. The

following is an average yield from 1 cord of pine-wood (United States Department of Agriculture, Forest Service Circular 114, 1907) ;—

Refined turpentine	7-12 gallons.
Total oils, including tar.	50-75 "
Tar	40-60 "
Charcoal	25-35 bushels.

The turpentine is of inferior quality and the operation has often been unsuccessful commercially.

In British Columbia the Douglas fir is the wood that would probably be used for charcoal-making. Tests have been made on the production of turpentine and pine-oils from this timber, and by the use of selected resinous material considerable quantities of these products have been obtained, both by the ordinary charring process and by steam distillation — the latter being preferable for the production of turpentine and oils. The latter process has appeared particularly attractive because the oils have been found to be suitable for use in the flotation process. Careful investigation has shown, however, that the yield of these by-products from the average run of Douglas fir is so much less than is obtained from the southern pines that the process holds out little hope of commercial success. In view of this it would seem best to char the wood in the cheapest possible manner for the production of charcoal, and either to ignore the by-products altogether, or to save only such as could be obtained at slight additional expense.

Reference may be made to a paper on the "Destructive Distillation of Fir Waste," by George M. Hunt, of the Forest Products Laboratory of the United States Department of Agriculture, Madison, Wisconsin. The paper deals specially with the yields of valuable products obtained by the distillation of Douglas fir. The following is the result of a series of experiments on the destructive distillation of mill-waste :—

TABLE I.—Average Yields of Valuable Products per Cord of 3,800 *lb. of Douglas Fir Mill-Waste.*

District.	Turpentine. Gals.	Other Oils. Gals.	80 per Cent. Alcohol. Gals.	80 per Cent. Acetate of Lime Lb.	Still Tar Gals.	Separator Tar Gals.	Charcoal. Lb.
Skagit County	0.8	4.4	3.9	71.1	10.7	16.3	1,072
Lake Washington	0.8	3.3	3.7	81.7	12.4	15.2	1,025
Grays Harbour	0.7	3.3	4.4	77.4	10.9	26.9	1,175
Hood's Canal	0.5	2.9	5.3	94.5	12.2	16.4	1,136
Average for State	0.7	3.5	4.3	81.1	11.5	18.7	1,102

The yield of turpentine and other oils is far less than is obtained from the southern pines, and the combined value of the by-products is too small to warrant the use of the expensive retort or oven process for their recovery. Mr. Hunt states :—

"In the destructive distillation of Douglas fir the value of the charcoal obtained will be more than the value of all the other products combined. Good charcoal, however, can be produced by burning in kilns and allowing the by-products to go to waste. The simplicity of a charcoal-kiln and the large units which may be employed make its first cost and subsequent operation much cheaper than the operation of a complete distilling and refining plant, and, unless the value of the extra products obtained at a complete plant is greater than the additional cost of operation, there is no advantage whatever in saving them. The yields obtained in these experiments do not show that there is any advantage."

He draws the following conclusions :—

"(1.) The steam and extraction process is not applicable to Douglas fir on account of the very low yield of turpentine and resin and the inferior quality of the latter.

"(2.) The utilization of Douglas fir stumps by destructive distillation is at present impracticable on account of low yields and high costs of handling the raw material. The yields are practically the same as from mill-waste, which can be more readily obtained and more cheaply handled.

"(3.) The utilization of Douglas fir mill-waste by distillation has not in the past proved successful, and under present market conditions, and with the methods of distilling and refining now in use, it is of doubtful feasibility :—

"(a.) Because the yields are, on the whole, considerably lower than those of the southern pine and Norway pine, which are hard to distil at a profit:

"(b.) Because the products have not been standardized and successfully refined, and are hard to sell:

"(c.) Because there is only a limited market on the whole Pacific coast for wood-distillation products."

It will be seen from Table I. that a cord of mill-waste, weighing 3,800 lb. yields about 1,100 lb. of charcoal when treated in a retort. The yield in a kiln would be slightly less than this, but it seems safe to assume that 2½ cords of such waste would suffice for the production of a net ton of charcoal.

The regular charcoal-kiln is a circular brick structure holding about 50 cords of wood. It is charged and discharged by hand, and the volatile by-products are partly saved by being drawn through condensers; the permanent gases being returned and burnt in the kiln. If a battery of these kilns were established at a large lumber-mill so that the waste wood could be delivered mechanically to the kilns, the production of a ton of charcoal might cost :—

2½ cords of mill-waste at $1.	$2.50
Labor and other expenses of operation after deducting the value of the by-products	2.50
Carriage of charcoal to smelter.	1.00
Total	6.00

For the electric-smelting plant about 40 tons of charcoal would be needed daily. Each kiln would yield 20 tons, but as the process is slow, requiring about fifteen days, some thirty kilns would be needed. The consumption of mill-waste would be about 100 cords daily. The lumber-mills in Vancouver are able to dispose of their waste as firewood in the city, but it seems reasonably probable that an adequate supply could be obtained at a nominal price by locating at one or two miles away from the city. In regard to mill-waste, it should be remembered that a large part of this is "slab-wood," and this consists largely of bark, which yields an inferior charcoal. I made some charcoal from Douglas fir bark and found that the charcoal, although light and weak, was coherent, and could probably be used for electric smelting in the open-pit type of furnace in admixwith wood charcoal. The wood charcoal is extremely pure, containing scarcely any ash, but the bark charcoal from my experiment contained as much as 3 per cent of ash. This probably indicates an appreciable amount of phosphorus, which would be undesirable when smelting for low-phosphorus pig-iron.

For the economical charring of mill-waste, it seems likely that a kiln could be devised that would allow of mechanical charging and discharging, and thus reduce the charge for labour, which must be the largest item in the cost of charcoal-making. I have given some attention to the design of such a kiln, but realize that numerous problems are involved, and that much experimental work would be needed before a full-sized kiln could be constructed. The recovery of by-products can be effected very economically by the use of the Cottrell electrical-precipitation process. Dr. J. G. Davidson has made a special study of this, and expects to continue his experiments at the plant of the Electrical Turpentine Syndicate in Vancouver.

One recent process for the production of charcoal is that of W. Thomas, which depends on forcing heated distillation gases through the charge of wood. I met Mr. Thomas and visited his plant in Nanaimo, but he had not at that time any information on which I could base a conclusion in regard to the cost at which he could make charcoal. Messrs. McPherson and Fullerton Bros. have, however, carried out a preliminary test with this process, and have sent me figures from which I conclude that if mill-waste could be supplied at $1 a cord, charcoal could be made at a cost of about $6 per net ton.

In regard to the possibility of establishing an electric-smelting plant in some more remote location, such as the Campbell river, and in view of the difficulty and expense of carrying so bulky and fragile a material as charcoal, it might be necessary to cut timber specially for charcoal making near the plant. Such timber felled, carried to the charcoal plant, and cut into pieces of suitable size would be likely to cost at least $3 a cord, and allowing 2½ cords per ton of charcoal, the wood alone would cost $7.50. Taking the net cost of charring as $2.50, after allowing for the value of the by-products, the final cost of a net ton of charcoal would be $10.

Charcoal Consumption per Ton of Pig-Iron.

For the production of pig-iron in the electric furnace, I estimate on a consumption of 0.4 net ton in the Swedish furnace, or 0.5 net ton in the open-pit furnace, per gross ton of pig-iron. In view of the statement, frequently made, that only 1-3 ton of charcoal is needed, I may explain why the higher estimate should be accepted.

It is recognized that in the open electric furnace reduction of iron oxide is effected substantially by means of carbon, with the liberation of carbon monoxide, which burns above the charge and is wasted. Theoretically, 1 ton of foundry pig-iron will need 0.269 ton of carbon for its reduction from magnetite and about 0.035 ton for its carburization, assuming it to contain 3.5 per cent of carbon. It will also need 0.026 ton of carbon for the reduction of 3 per cent of silicon. The combined carbon requirement will thus be 0.33 ton per ton of pig-iron. On account of the well-known purity of wood charcoal, it is often assumed that it contains at least 90 per cent of carbon, and that some 0.38 ton of charcoal will be sufficient per ton of pig-iron. Actually, however, charcoal contains from 70 to 75 per cent of fixed carbon; the average over a long period in Sweden being 73 per cent; the balance being volatile matter and moisture, and short ton, it appears that ½ net ton of charcoal will accordingly some 0.44 to 0.47 ton of charcoal must be provided. In view of the custom of weighing iron by the long ton and charcoal by the short ton, it appears that ½ net ton of charcoal will be required. There is, indeed, a small amount of reduction by carbon monoxide, even in the open furnace, but this will be balanced by the combustion of charcoal at the top of the furnace and the other mechanical losses. Assuming that 5 per cent of the carbon monoxide is utilized in the open furnace and 25 per cent in the Swedish furnace, we find that 0.4 net ton of charcoal should be enough in the latter type of furnace. Mr. Gronwall, in his estimate, quoted in my report on "Electrothermic Smelting of Iron Ores in Sweden," allows 0.370 metric ton of charcoal per metric ton of foundry iron, and this would be 0.414 net ton per long ton of pig-iron. It will be seen, therefore, that my estimate is supported both by theoretical calculations and by the results of practice in Sweden.

I place here an account of my experimental production of charcoal from Douglas fir and of my investigation of Mr. Thomas's processes for the production of coke and charcoal.

Charcoal from Douglas Fir.

(Test made at McGill University, August, 1918.)

I was furnished by Dr. Bates, Superintendent of the Forest Products Laboratories, with samples of wood and bark of the Douglas fir, on which the following tests were made:

1. *Piece of Wood.*—14 inches long, 6 inches wide, and 4.75 inches high. The piece was not square, but of the section shown. Weight, 3,375 grammes; moisture 14.74 per cent of dry wood or 12.85 per cent of moist wood.

The wood was placed in a muffle-furnace, and heated slowly to a temperature of 440 deg. C. The operation lasted in all about seven hours, and it remained at the highest temperature for about one hour. When cool the charcoal came out in three pieces, it having broken transversely. The pieces put together measured 13 x 5.5 x 4 inches, or 71.6 per cent of the original volume, and the weight was 1,134 grammes. This is 33.6 per cent of the original weight, or 38.5 per cent of the weight of the dry wood. The charcoal was tested by heating to redness in a covered crucible and lost 28 per cent of its weight; as the ash is very small, this means 72 per cent of fixed carbon. The charcoal, while not quite as dense as hardwood charcoal, was satisfactory in character, except that a part of the interior was soft and spongy. This was not due to a difference in the wood itself, as this was uniform, but to the decomposition of the issu-

ing gases, which consolidated the outer portions of the charcoal. These denser layers varied from 0.25 to 1.5 inches in thickness, and occurred on all the surfaces. The ash in this charcoal was extremely low, being only 0.1 per cent.

II. *Piece of Bark.*—12.25 inches long, 6.75 inches wide, and 4.4 inches thick, of the shape shown in section. Weight 2,595 grammes; moisture, 16.73 per cent of dry bark or 14.34 per cent of moist bark.

The bark was placed in the muffle-furnace and heated like the wood, except that the final temeperature was a little higher, being about 500 deg. C. Next morning it was found that air had entered through cracks and had burned part of the charcoal, which was actually ignited when taken out. The charcoal was in one piece and used 11.25 x 6.5 x 4.5 inches, or 91 per cent of the original volume. It will be noticed that the bark had swelled somewhat in a radial direction while charring. The weight was 882 grammes, and it would probably have been 890 grammes if no combustion had taken place; 890 grammes would be 34.3 per cent of the original bark or 40.1 per cent of the dried bark.

The charcoal lost 19 per cent of its weight on ignition in a closed crucible, which would correspond to 78 per cent fixed carbon, allowing for the ash. The ash was 3 per cent of the charcoal.

The charcoal was light and weak, so that it would crush easily under a load; it was reasonably coherent and did not crumble very much on handling.

Conclusion.—The slow charring of Douglas fir wood yields a charcoal which, though not as strong and dense as hard-wood charcoal, would be quite satisfactory for use in electric smelting. The charcoal is extremely free from ash, from which it may be inferred that the phosphorous will be very low. The bark yields an inferior charcoal which, however, might be used in admixture with the wood charcoal. The high percentage of ash makes it probable that the phosphorus would also be high, and indicates that bark charcoal should probably be excluded in the production of specially pure low-phosphorus pig-iron.

Comparative tests were made on the density of pieces of charcoal from Douglas fir and from hard wood. The volume of each piece was determined by surrounding it with fine sand. The following results were obtained:

	Specific Gravity.	
Douglas fir charcoal	0.394	
	0.363	mean 0.38
Douglas fir bark charcoal	0.308	
	0.289	mean 0.31
Hard-wood charcoal	0.441	
	0.486	mean 0.46

I wish to express my thanks to Mr. Stokes, of the Forest Products Laboratories, who made the moisture determinations and prepared the pieces of wood and bark for the test.

A Note on the Walter Thomas Processes for Making Carbonized Fuel.

At the request of the Honorable Mr. William Sloan, I made a short investigation of these processes and of the plant at Nanaimo where some of them have been tested.

In general, these processes are for the purpose of producing coke from coal and charcoal from wood. The general principle employed is to heat the coal or wood in a closed vessel by passing through it hot gases obtained by distillation from the same material; these gases being heated in a pipe stove or a regenerative brick stove. The distillation products from the fuel are cooled and treated by the Cottrell electrical-precipitation process, thus obtaining oils and other condensible by-products; the permanent gases being then reheated and forced into the coal or wood, as stated above; the chief advantage to be gained being the production of certain oils which would not be obtained by the usual high-temperature distillation. Another claim is that the passage of the distillation gases through the fuel causes the deposition of carbon, and thus increases the yield and improves the quality of the coke or charcoal. It is also claimed that the operation will be more rapid, as the heat is conveyed by the gases directly into the fuel to be treated instead of by conduction through the walls of a retort.

Another process for the production of charcoal from sawdust is carried out in a revolving drum, which is heated by burning the permanent gases from the distillation in flues in the walls of the drum. The charred product is briquetted with tar, and is heated in a carbonaceous gas in such a way as to produce a very dense charcoal.

I visited the plant at Nanaimo on July 4th, 1918, in company with Mr. Walter Thomas and Mr. Wm. Brewer. The plant occupied two or three rooms in an old brewery, and consisted of the following apparatus:—

(1) A distillation retort consisting of a vertical iron cylinder about 14 feet high and 5 feet in diameter. It was lined with bricks, so that the internal diameter was about 3 feet at the top and about 3 feet 6 inches at the bottom. The retort was intended for treating coal, which was introduced through a door in the top, while the resulting coke was withdrawn through a lateral door near the bottom. The coal rested on a perforated iron plate level with the bottom of this door, leaving a space below the plate for the removal of the products of distillation.

(2.) A pipe stove consisting of some iron pipes heated by a fire of wood, through which the permanent distillation gases passed on their way to the retort.

(3.) A condenser consisting of some water-cooled pipes for cooling the vaporous products of distillation.

(4.) A "treater-tube" or electrical-precipitation apparatus, consisting of a vertical pipe containing centrally an insulated piece of piano-wire, which could be charged to 60,000 volts, for precipitating the oil and tar vapours.

(5.) A fan or blower for causing the circulation of the gases.

(6.) A series of pipes connecting the several apparatus together, and permitting by means of valves various changes in the circulation system.

When the plant was in operation a charge of coal was placed in the retort, which was then tightly closed. The blower was started and the pipe stove heated. The air contained in the system was forced in a heated condition into the top of the retort; it passed down through the coal and passed out at the bottom, after which it passed through the condenser and the "treater-tube," and so back to the blower and again through the pipe stove to the retort. As the coal became hotter, gases would be given off, which would replace the air in the system, and thus after a time the blower would be forcing distillation gases through the stove and retort.

The plant was not in operation at the time of my visit, but had previously been tried with about 9 tons of coal from the Nicola valley. I understand that the charge of coal in the retort was about 3 tons. Dif-

ficulty was experienced in making the gas pass through the coal in the retort, using a pressurer on the inlet side and a suction on the outlet side of about 10 inches of water. Oils were obtained, amounting to about 60 gallons for the 9 tons of coal, and a semi-coked smokeless fuel was obtained from the retort; but as far as could be observed there was no production of permanent gas.

The above-mentioned test was made about February, 1917, and lasted for about five weeks. Dr. J. R. Davidson, of the University of British Columbia in Vancouver, installed and operated the electrical-precipitation apparatus and supervised the whole test. I have discussed the matter with him, and he stated that the non-production of any permanent gas was inexplicable to him, as there was not enough leakage to account for it, and that in view of this it was not desirable to attempt to draw any definite conclusions.

Speaking generally, however, I may point out that the processes have the following drawbacks:—

(1.) When treating coking-coal it will be difficult to obtain even moderate rapidity of operation. This to pass the gas through it at all rapidly, and the coking will consequently be extremely slow.

(2.) The circulating gases have not a great heat capacity, and a very rapid circulation will be needed will be less serious in the case of wood than of coal, as the necessary temperature is so much lower.

(3.) The thermal efficiency of the system will be small, as much of the heat produced in the pipe stove will go up the chimney, and the fuel consumption will in consequence be high.

(4.) The pipe stove will be costly to build and to maintain, as the pipe will burn out rather quickly.

(5.) It does not seem probable that the circulating gases will deposit carbon in the coke or charcoal, as claimed, because they must first pass through the pipe stove, which must be at a higher temperature than the fuel, and they are more likely to decompose and deposit carbon in the pipe stove. It is conceivable, however, that the coke or charcoal may in some way cause the deposition of carbon in itself, even though the gas has previously been exposed to a higher temperature.

Mr. Thomas had shown me samples of carbonized charcoal, which is certainly a very satisfactory product. He has not, however, as far as I am aware, published or patented his method of making this dense product, and I have no reason for supposing that it can be done economically on a large scale.

In conclusion, although I am not prepared, on the information at my disposal, to recommend the processes and apparatus of Mr. Thomas for commercial operation, I recognize his ingenuity as an inventor, and think it quite likely that some of his ideas, if carefully tested and applied, may prove fruitful. Since returning to Montreal I have heard from Messrs. McPherson and Fullerton Bros., of Vancouver, who have taken over the Thomas patents and have been making some tests of the Nanaimo plant. I have received from them samples of charcoal made from fir-wood in the large retort. The operation was stated to occupy only six hours and the charcoal appears to be of satisfactory quality. I have also received from them some small briquettes made from charcoal powder by the Thomas process. They state that they can obtain mill-waste for a few cents per cord; and apparently they can make charcoal at a cost of about $5 per ton.

Substitutes for Charcoal in Electric Smelting.

Coal and Coke.—For the purpose of this investigation I have been furnished by Mr. Wm. Fleet Robertson and others with information with regard to the supplies of coal and coke in British Columbia. In view of my belief that charcoal will be the main reducing agent in the electric smelting of iron ores in this Province, I have not paid much attention to the supply of other fuels. Coke can be used to some extent in admixture with charcoal, and coal or oil would be needed for the operation of open-hearth and other furnaces.

The following information with regard to the supply, analysis, and price of coal and coke was supplied by Mr. W. F. Robertson under date of June 5th, 1918:—

Vancouver Island.—Monthly coal production, 145,000 tons; price per ton, $2.50 to $5.86, depending on grades. Monthly coke production, 3,000 tons; price, $10.25 per ton.

The coke contains 74 per cent fixed carbon, 3 per cent volatile matter, 23 per cent ash, and 1 per cent sulphur; but under improved conditions coke could be made that would contain 84 per cent fixed carbon, 3 per cent volatile matter, 13 per cent ash, and 1 per cent sulphur.

The following information with respect to the Nicola Valley coal was supplied to me by Mr. Nichol Thompson under date of June 10th, 1918:—

"The Nicola Valley coal produces a superior metallurgical coke with well-developed cell-structure and ample strength fo riron-furnace stoaks. From English coking tests the following results were obtained:

	From Raw coal.	Coke produced in: Bee-hive Ovens.	Retort Ovens.
	P.c.	P.c.	P.c.
Moisture	3.40	1.20	1.00
Volatile matter	34.90	1.20	0.50
Fixed carbon	56.70	84.00	91.25
Ash	5.00	13.60	7.00
Sulphur	0.65	0.63	0.25
Totals	100.00	100.00	99.75

From another source in England:—

"The coal sent to me and numbered 1 is a very fine coal for metallurgical, steaming, or domestic purposes. We can take away every trace of sulphur if necessary, and it would then remain a splendid metallurgical coke, supposing you had a steel plant in British Columbia. I should imagine that this No. 1 sample is about the highest-grade coal you have in Canada, and it should be used as a superior coal when British Columbia has commenced steel production. In other words, it is a coal which will find higher values as British Columbia develops. The other coal, main coal and number 2, seam 1, carried 38 and 40 per cent volatile matter, and are excellent for oil and motor-spirit production, and for the production also of an excellent coke either for ordinary household fuel or for metallurgical work. The oil extracted from the coal would depend entirely on the grade of coal which you wished to produce. The coal could be distilled to destruction or any stated quantity of hydrocarbons could be left in the coke. I enclose you a sheet showing the product from 1 ton of Nicola Valley coal obtained from a by-product oven. There is no question as to the success of the by-product coke-ovens, as evidenced by the fact that the entire coal product of Germany previous to the war was made into coke so that the products might be saved."

Mr. Thompson gave me further information with regard to the chemical by-products obtainable in the coking of the Nicola coal, but it does not seem suitable to discuss these in the present report.

Gas-retort residue.—The electric-smelting plant at Bay Point, San Francisco, employs for reducing reagent in the production of ferro-alloys a carbonaceous residue produced in the manufacture of illuminating-gas from oil. This material is practically ash-free, it contains about 70 per cent of fixed carbon and is obtainable at a nominal price of about $4 a ton. It is not very satisfactory physically, but in view of the scarcity of charcoal and coke in that locality the management have been obliged to use this residue and have overcome the difficulties attending its use.

Comparison of Coke and Charcoal.—The comparative values of these as reducing materials depend in the first place on their fixed-carbon content. Thus, if charcoal contains 73 per cent of fixed carbon and coke 84 per cent, the coke would appear to be the more valuable. The remainder of the charcoal, however, is volatile matter and moisture, which is driven off harmlessly in the furnace, while the coke would contain some 13 per cent of ash, which has to be melted, and will usually necessitate the addition of a flux. The sulphur in the coke also will need fluxing, in addition to lowering the purity of the resulting pig-iron. It follows, from these and other considerations, that charcoal is somewhat more valuable than coke as a reducing reagent. Referring to Mr. Gronwall's estimate in my Swedish report, the following figures show the relative consumption of fuel and of electric power for 1,000 kilograms of pig-iron, according as charcoal or coke are employed:

	Using Charcoal of 73 Per Cent Carbon.		Using Coke of 85 Per Cent Carbon.	
	Kilos Fuel.	H.P. Year.	Kilos Fuel.	H.P. Year.
White pig-iron	340	0.37	370	0.39
Grey pig-iron	370	0.40	400	0.42

It will be clear from this table that not only is there a larger consumption of coke than of charcoal per ton of iron, but the power consumption is larger with coke.

In localities where coke is of good quality, cheap, and abundant, while charcoal is expensive and scarce, it may be worth while to use coke on account of its greater cheapness. In British Columbia, however, it appears that charcoal should be made at a cost of $6 to $8 a ton, while coke would cost about $10 a ton. As long as these conditions last there can be little doubt that charcoal will be preferable as a reducing agent in electric smelting.

APPENDIX VI.

Electrodes.

Electrodes are needed in most electric furnaces for conducting the electric current into the furnace. They should be good conductors of electricity and poor conductors of heat, and they should be strong and capable of withstanding high temperatures. Electrodes are usually made of some form of carbon, and their wear in the furnace, from exposure to air or to other oxidizing materials, constitutes a serious source of expense. The cheapest kind of electrodes are "carbon" electrodes, which are made of some form of carbon, such as crushed anthracite coal, bonded together with pitch, and baked. "Graphitized" electrodes are obtained by heating carbon electrodes to a very high temperature in an electric furnace. The process converts the amorphous carbon of the electrode into graphitic carbon, which is a much better conductor of electricity, and is superior in some other respects. Graphitized electrodes cost about three times as much per pound as carbon electrodes, and the latter are therefore more generally used in electric smelting.

The electrodes used in the Swedish furnaces at the time of my visit in 1914 were 24 inches in diameter and 4 or 5 feet long. They were provided with threaded ends, so that fresh lengths could be added as the electrodes wore away. They were of amorphous carbon and cost about 4 cents per pound. The consumption of electrodes, when making white pig-iron from high-class ores, was about 10 to 15 lb. per ton of pig-iron; thus costing about 50 cents per ton of product. In melting lower-grade ores for foundry iron the consumption might be from 15 to 20 lb.; at present prices in British Columbia this would mean about $1.50 per ton of pig. A furnace of 3,000 kw. uses six of these 24-inch electrodes.

At Bay Point, California, the 3,000-kw. open-pit furnace, smelting ferro-manganese, uses three 24-inch carbon electrodes. The consumption is 100 lb. per ton of ferro-manganese, and Beckman and Linden expect that in using this furnace for making pig-iron the consumption would be of 20 lb. per ton.

It will be noticed that the Swedish furnaces have twice as many electrodes as the Californian furnace. The size and number of the Swedish electrodes are in agreement with the generally accepted formulae of Dr. Hering, and it seems likely, therefore, that the Californian furnace should have more electrodes if it is to be used for iron-smelting. Beckman and Linden do not agree with this suggestion, and, of course, these points must ultimately rest on practical demonstration, but it must be remembered that they have not as yet applied their type of furnace to smelting iron ores.

At Heroult, California, a 3,000-kw. ferro-manganese furnace is furnished with four 12-inch graphitized electrodes, which would be about the same in effect as the three 24-inch carbon electrodes at the Bay Point plant. Judging by the consumption of electrodes at this point, it appears that it would be preferable to use carbon electrodes, and I understand that this change will be made.

Under ordinary conditions carbon electrodes cost 3 or 4 cents per pound, but at the present time the price in the East is about 8 cents and on the Pacific coast nearly 10 cents. In view of the expense of shipping electrodes across the continent it is desirable to make electrodes locally, but this should not be undertaken until the smelting plant is in good running-order, because the manufacture of electrodes is not easy, and the use of poor electrodes might delay, seriously, the operation of the plant. Messrs. Beckman and Linden have put up an electrode plant at the Bay Point plant, and they are trying to make electrodes from the carbon residue, which they use as reducing material in the furnaces. They prepared for me the following estimates of the cost of plant and of making electrodes:—

300-ton-per-month Electrode Plant.

Baking-kilns complete, including all burning apparatus	$ 20,000
Hydraulic press (500 tons per month, 600-ton pressure)	6,000
Mixers (two)	6,000
Moulds	5,000

Calciner complete	40,000
Building complete	25,000
Crane	8,000
Conveying equipment and elevators	2,500
Crushing and screening apparatus	3,000
Kiln-sand	1,000
Tools, chains, etc.	1,000
	$118,500
Contingencies, 10 per cent	11,850
	$130,350
Beckman & Linden Engineering Corporation fee	15,000
Total	$145,350

Cost of making 2,000 Lb. of Electrodes.

Anthracite coal, calcined, crushed, and sized	$20.00
Pitch at $20 per ton put into electrodes	5.00
Baking fuel, pound per pound ratio	4.50
Labor, 50 cents per hour	12.75
Operating superintendence	1.85
Supplies	1.00
Maintenance	2.00
Plant office expense	75
Main office expenses	4.00
Total	$51.85

Cost per pound, $0.0258.

The iron-smelting plant under consideration for British Columbia was to have two 3,000-kw. furnaces making pig-iron and three 300-kw. furnaces making ferro-alloys. The consumption of electrodes in these furnaces would amount to 1,000 or 1,500 lb. daily, or about 20 or 25 tons per month. This is less than one-tenth of the output of the plant described above, and the cost of making electrodes in a smaller plant would necessarily be somewhat higher, say 3 or 4 cents per pound.

APPENDIX VII.

The Supply of Labor.

Although a supply of competent labor is essential to the success of any industrial undertaking, and although the variations in the wages that must be paid may mean the difference between profit and loss, it is impossible for me at the present time to put forward any really reliable information with regard to labor conditions in British Columbia.

The Department of Labor in Victoria has furnished me, through Mr. W. Fleet Robertson, with a statement of the supply, nature, and cost of labor in the Coast District of British Columbia; this statement is added in the following pages. It will be seen that there is a fair supply of laborers at nearly $4 a day, and that most skilled men are scarce at about $6 a day. The cost of labor per ton of iron depends very much on the size and output of the plant. Thus, at the figures mentioned, in a fully equipped plant making 50 or 60 tons of pig-iron, and steel and ferro-alloys as well, the cost of labor might be $4 or $5 per ton of iron, but if only one or two furnaces were operating the labor cost might be about $7 per ton of iron.

While electric furnaces offer difficulties and dangers of their own, it appears to me that a well-established electric-smelting plant, such as those I saw in Sweden, presents far less difficulty and discomfort to the work-

Memorandum From Department of Labour, Victoria, B.C., June 10th, 1918.

Supply, Nature, and Cost of Labor, Coast District of British Columbia, such as would be required at Plant for Electric Smelting of Iron.

	Normal Pre-War Conditions. Wages per Day of Eight Hours.	Present Conditions. Supply Plentiful or Scarce.	Present Conditions. Wages per Day of Eight Hours.
Engineer, 1st	About $15 less than at present	Scarce	$225 per month of 26 working-days.
Engineers, 2nd	......	Scarce	$165 per month of 26 working-days.
Machinists	$4.00 per day	Scarce	$6.00 per day.
Machinists' helpers	2.50 per day (Not quite sure)	Scarce	4.50 per day.
Boiler-makers	$4.00 per day	Scarce	6.00 per day.
Boiler-makers' helpers	3.25 per day	Scarce	4.30 per day.
Blacksmiths	4.50 per day	No great supply	6.00 per day.
Blacksmiths' helpers	3.25 per day	No great supply	4.50 per day.
Plumbers and pipe-fitters	5.00 per day	Scarce	6.00 per day.
Plumbers' and pipe-fitters' helpers	3.25 per day	Scarce	4.00 per day.
Painters	4.00 per day	No great supply	5.50 per day.
Electrical workers	5.00 per day	Very scarce	6.00 per day.
Electrical workers' helpers	3.50 per day	Very scarce	4.00 per day.
Operators of electric, steam, or air winches and donkeys	4.50 per day	Scarce	6.60 per day.
Engineers in charge of boilers	4.00 per day (Not quite sure)	Scarce	5.50 per day.
Laborers	$3.00 per day	Supply fair	3.85 per day.
Sheet-metal workers	......	Fair	6.60 per day.
Coppersmiths	......	Fair	6.60 per day.

man than the average blast-furnace plant, and that the management should experience less difficulty in keeping a good crew of men.

On page 34 of my Swedish report it is stated that at Hagfors three 3,000-horse-power furnaces are operated by fifty men, working eight hours daily, at a wage of about 12 cents per hour. At this rate, with bonuses and the higher rates of foremen, the cost would amount to about 80 cents a ton of pig-iron. In a plant of three 3,000-kw. furnaces in British Columbia fifty men might be assumed to cost: Thirty at $4 and twenty at $6, or $240 a day. With an average output of 75 tons daily of foundry iron this would mean $3.20 per ton. A plant of this size would probably need a few additional men, say ten or twelve, which would increase the charge for labor to about $4 a ton.

Messrs. Beckman and Linden have given me a list of the men needed daily for one 3,000-kw. furnace of the open-pit type. I have added to these the rates of pay, estimated with the aid of the attached memorandum:—

Daily Labor for One 3,000-kw. Pit Furnace.

One furnace foreman at $8	$ 8.00
Twelve furnacemen at $5	60.00
One chief electrician at $6	6.00
Three sub-station operators at $5	15.00
Three mechanics at $6	18.00
Six mixing-men at $4	24.00
Six metal-handlers at $4	24.00
Two locomotive-crane men at $5	10.00
Total	$165.00

With an output of 25 tons per day this would mean $6.60 per ton of iron, which agrees with Beckman and Linden's estimate in Appendices X and XI. This charge is unduly high, because they figured on a single furnace only. A plant having three furnaces would only need about twice as many men as a plant with one furnace, so that the cost for labor would be about $4.40 per ton.

MacKinnon Steel Co., Ltd., Sherbrooke, Que.

We have just taken a contract for the supply of all necessary steelwork in conection with eight story apartment house being erected on Drummond Street, Montreal by R. R. DuTremblay. The name of the general contractor is Alex. MacKay, Montreal. The valuation of the complete structure is five hundred thousand dollars, and the steel work will amount to approximately sixty thousand dollars.

TREATMENT OF PEAT BY PRESSURE.

In the improved Ekenberg process of treating peat as tested at Cheauteauneuf, Bretagne, France, the raw material is first compressed to reduce the water from about 90 per cent. to 60 per cent. It is then subjected to the action of superheated steam at 160 degrees C. for 25 minutes, and is afterwards again compressed or at once dried in special chambers, or in the open air. "Turbon," as the proluct is called, still retains 20 to 25 per cent. of moisture. It yields 61 per cent. of volatile matter, and its calorific value is 10 per cent. higher than that of ordinary peat. It is recommended for direct firing, for gasworks where ammonia can be recovered, and especially for power gas for internal combustion engines. Such processes so far have never been found to be very economical, on account of the colloidal nature of the peat skin.—Canadian Chemical Journal.

PULVERIZED COAL AS THE RECONSTRUCTION FUEL FOR ALL INDUSTRIAL HEATING OPERATIONS.

By C. F. HERINGTON, M.E.

There is at the present time in Canada, as throughout the world, a period facing all iron and steel manufacturers, which is called for want of a better name, "Reconstruction," meaning that the time has arrived for them to take stock of their facilities, and to so reconstruct these facilities as to take the best advantage of the coming years of prosperity which we are assured lies ahead of us.

The manufacturer can readily see that prices for material are being lowered, and that he cannot continue getting out his production regardless of the cost, but must seriously consider the relation of this cost to the quantity of production he is able to furnish Perhaps the greatest single item of this is the cost of heating operations per ton of output.

The manufacturer is also confronted with the prospects of a scarcity of fuel as the oil and natural gas upon which he has depended for so long is being played out faster than new wells can be found. The need of the day is for ships and then more ships, and the logical fuel for ships has been found to be fuel oil, so that in a few years a coal burning ship will be a novelty.

It is in this connection that pulverized coal has come to the front as the Reconstruction Fuel for it has proved its adaptability for many kinds of heating operations. This fuel is economical in its consumption, it is controlled at the furnace in a simple and efficient manner, and has many other advantages that will be brought out in this article.

During the past three or four years in the United States, there has been installed over 75 powdered coal plants, which is equivalent to saying that over 2,500 heating furnaces of various kinds are now using powdered coal as a fuel. In Canada several plants have been installed, and here, as elsewhere, great interest is now being shown in the operation of these powdered coal plants.

To help the manufacturer to make a comparison between the fuel he is now using and powdered coal the following table is given:

Equivalent Prices of Powdered Coal and Some Other Fuels.

Powdered Coal 14,000 B.T.U. per pound.	City Gas 650 B.T.U. per Cu. Ft.	Natural Gas 1,000 B.T.U. per Cu. Ft.	Fuel Oil 140,000 B.T.U. per Gal.
$1.00 per ton.	$.0235 per M.	$.035 per M.	$.005
1.50 " "	.035 " "	.054 " "	.075
2.00 " "	.047 " "	.072 " "	.01
2.50 " "	.058 " "	.092 " "	.0125
3.00 " "	.07 " "	.108 " "	.105
4.00 " "	.094 " "	.144 " "	.02
5.00 " "	.117 " "	.18 " "	.025
6.00 " "	.14 " "	.216 " "	.03
8.00 " "	.188 " "	.288 " "	.04
10.00 " "	.234 " "	.36 " "	.05
11.00 " "	.27 " "	.395 " "	.055
12.00 " "	.30 " "	.43 " "	.06
13.00 " "	.324 " "	.465 " "	.065
14.00 " "	.34 " "	.50 " "	.07
16.00 " "	.39 " "	.57 " "	.08
18.00 " "	.44 " "	.65 " "	.09

The following analysis is a fair average of the coal that will give the best results:

Fixed Carbon	54.00%
Volatile Matter	32.75%
Ash	12.00%
Moisture	1.25%

Figure 1 shows a perspective view of a powdered coal plant having a capacity of 10 tons per hour; the operation of the plant is explained as follows:

Cars containing the raw coal are placed on the track hopper; the coal is dropped into the hopper and is then fed by means of a duplex reciprocating feeder, one inch size. It is then carried by a belt conveyor to a centrifugal discharge bucket elevator, from which it is delivered through a 12" screw conveyor to a 300 ton capacity crushed coal storage bunker. A magnetic separator is placed over the belt conveyor to remove the magnetic material from the coal.

The coal is delivered from the bottom of the storage bunker, through a number of gates and is carried on a belt conveyor driven by a variable speed motor, to an automatic scale, where it is weighed and discharged through a screw conveyor into the coal dryer.

The coal dryer consists of a single shell, five feet in diameter by 50 feet long. It is driven by a 15 H.P. motor through a silent chain drive completely enclosed in an oil tight and dust proof casing. The dryer is fired by hand and the coal is dried by the heated gases which pass at a low velocity in the opposite direction to the flow of the coal. There is no loss of coal in this dryer as no exhauster or collector are employed. The dryer has a capacity of ten to fifteen tons of bituminous coal per hour, removing the moisture to less than one per cent.

From the dryer the coal passes into a small bucket elevator, where it is lifted and discharged into a five ton capacity dried coal bin placed between two 36" diameter, five ton capacity Bonnet pulverizers. The coal is fed by a pusher-feeder from the dried coal bin into each of the pulverizers. Each pulverizer is driven by a 75 H.P. motor through a silent chain drive enclosed in an oil tight casing.

From the air separators of the pulverizers the coal dust is drawn out by means of cast iron mill exhausters of the Bonnot Type, and discharged into a collector placed on top of a 25 ton capacity powdered coal storage bin. These bins are cross-connected by means of a by-pass screw conveyor driven by a reversible motor, and placed under the discharge spouts of the collector, so that the coal dust from either of of the pulverizers can be discharged into either of the 25 ton powdered coal storage bins. The return pipe from the top of the collectors is carried back to the side of the pulverizer, thereby maintaining the vacuum in the air separator.

The pulverizers are of extra heavy construction throughout, with no wearing parts, inside the mill, that require lubrication. The mill has a horizontal drive with the two outside bearings so that the mill can run continuously for a long time without the necessity of shutting down for lubrication. Also the driver and ball are easily accessible for repairs and replacement without requiring the complete dismantling of the mill to renew the wearing parts.

Placing the powdered coal bins in the coal plant eliminates the risk of storing large quantities of powdered coal over or near high temperature furnaces and reduces the danger of spontaneous combustion in the storage bins. Also with this system, there is no danger of the powdered coal caking in the bins as in the case of separate bins, as that coal dust is continually being drawn out at the bottom of the bin, and the coal that has not been used in the furnaces is returned and discharged into the top of the bins through a collector. Another advantage is that all of the powdered coal in the plant is available for any of the furnaces.

From the storage bins, the coal is usually fed by means of feed screws into the suction side of the distributing blowers. But, in this particular plant, the powdered coal was required for over 200 furnaces scattered in shops which covered an area of 100 acres. So it was found necessary to devise a system to distribute the powdered coal, first to the different shops and then to the several furnaces located in each shop.

This was done by making the powdered coal plant the main supply station, and locating sub-stations at or nearby the shop in which the coal was to be used. Ejector tanks were placed in pairs under the 25 ton powdered coal storage bins and were cross-connected. From these the powdered coal was distributed through extra heavy wrought iron pipes to the different sub-stations. Each tank holds about 4 tons of coal, and with compressed air at a pressure of 45 pounds it is possible to fill the tank and deliver the coal a distance of 500 feet in 8 minutes.

At the sub-station the coal is discharged into a special collector which in turn is vented into another collector so as to catch the fine dust and prevent any coal dust escaping into the atmosphere. The coal is deposited in a bin having a capacity enough for a day's supply to that particular shop. From this bin the coal is fed by small screws into the suction side of the distributing blower and distributed to the several furnaces through branch pipes and burners. Then completing the circuit the coal line is brought back to the collector on top of the sub-station bin and discharged into the bin.

The distributing blowers which are used at each sub-station are made of cast iron with the scroll cast in one piece. The blast wheels are overhung, the blades are made of soft steel, and the blowers are equipped with Timken Roller bearings. One of the desirable features of these Bonnot Blowers is the facility in which the motor can be disconnected and the blast replaced without disturbing in any way either the suction or distributing piping.

The mixture of coal dust and air in the distributing mains is of a non-combustible character, and will not burn in the furnace without the addition of secondary air at the burner. This mixture is controlled in the coal plant by means of an air indicator and automatic regulator.

When a valve on any coal dust branch pipe leading to a powdered coal burner is opened or closed by the furnace man, the difference in pressure caused by the opening or closing of the valve is felt in the vent line, in the coal plant, which has a volume float governor and air indicator between it and the suction side of the distributing blower. The float rises or falls according as the valve opens or closes, and immediately the automatic regulator controls the speed of the motor which drives the feed screws which feed the powdered coal into the suction side of the blower. In this manner the quality of the coal dust and air is never changed, while the quantity can be varied to suit the requirements of the furnaces in all the shops.

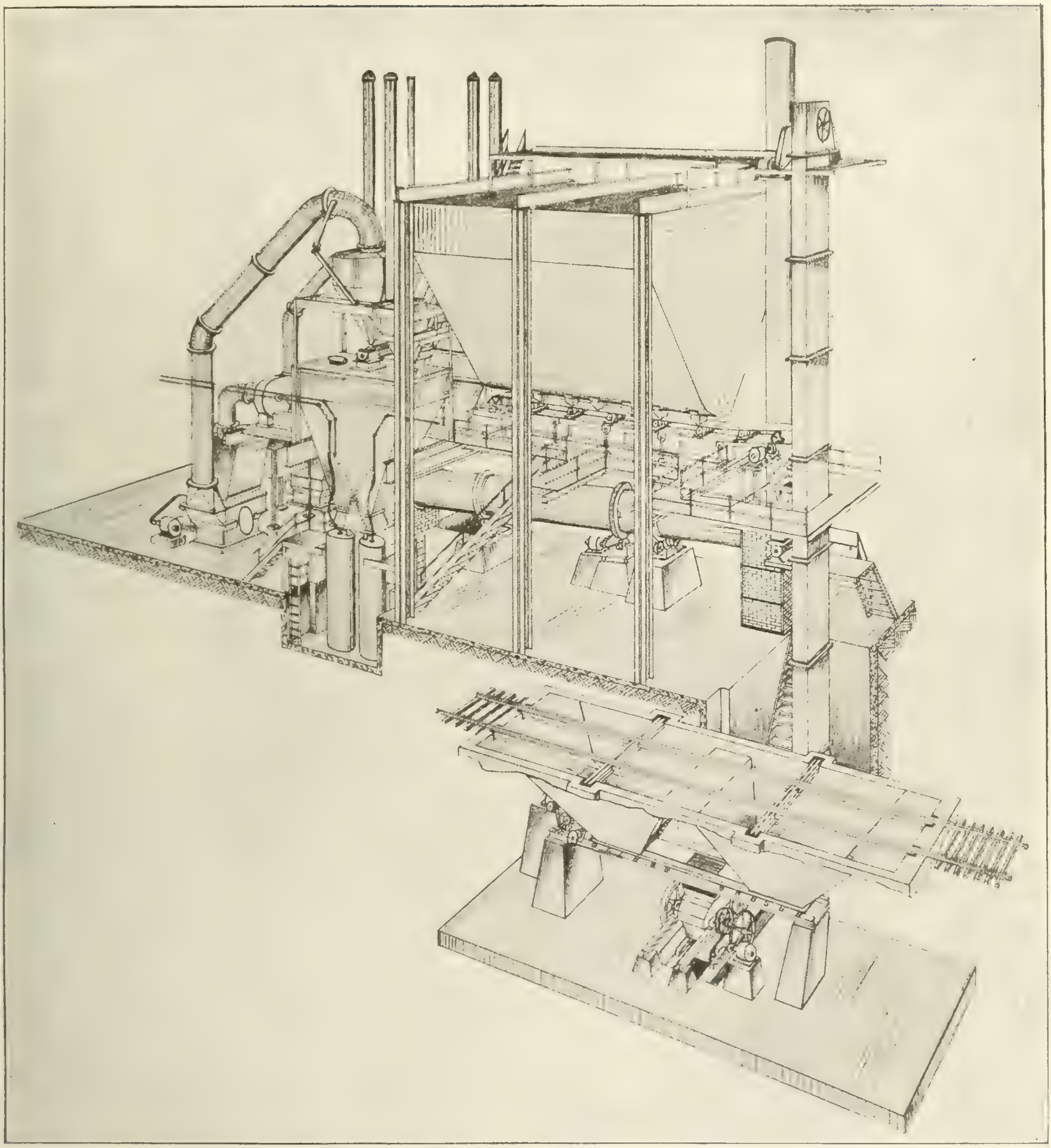


Figure 1.
10 ton per hour powdered coal plant.

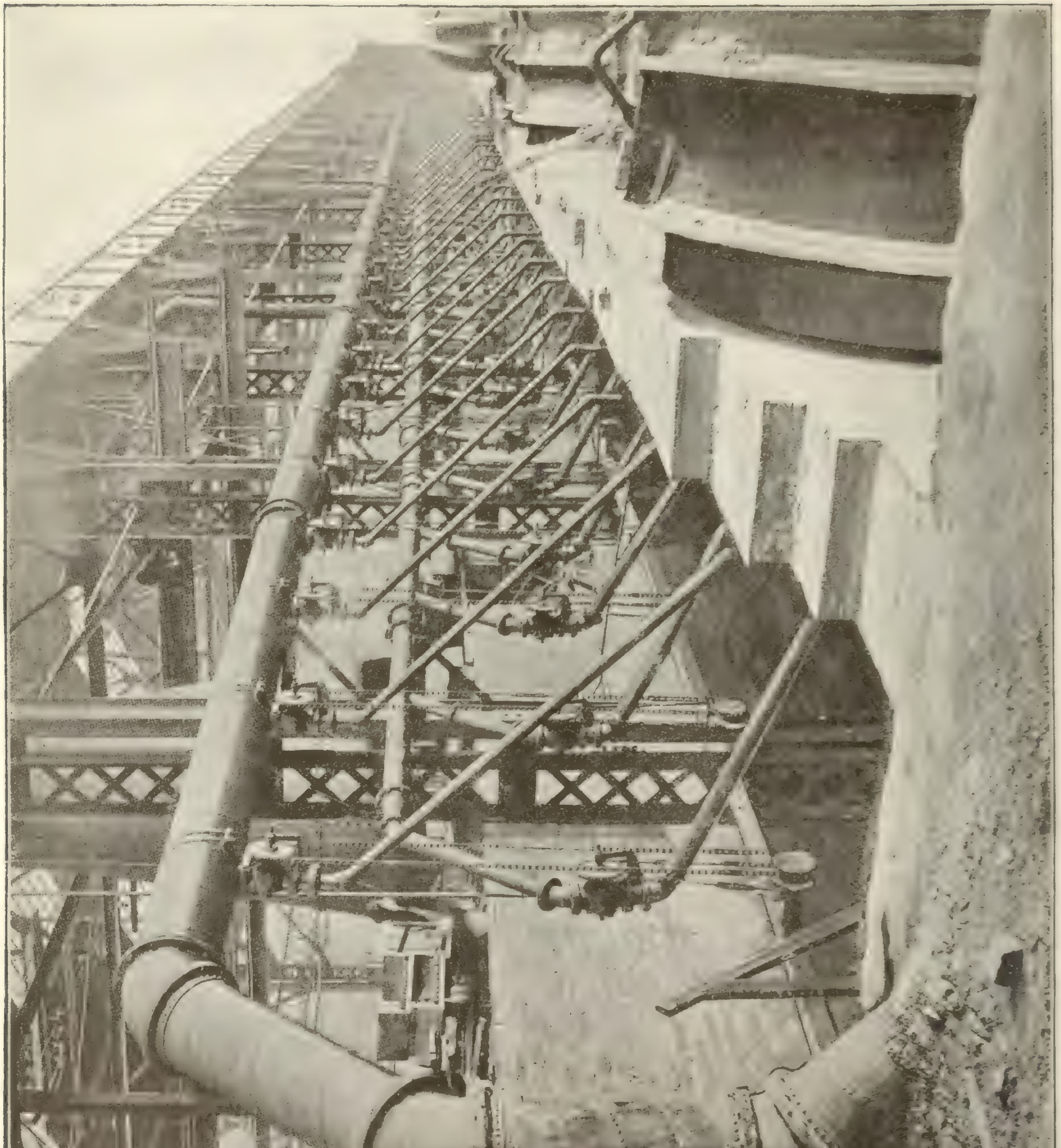


Figure 2.
Row of annealing furnaces using powdered coal as a fuel.

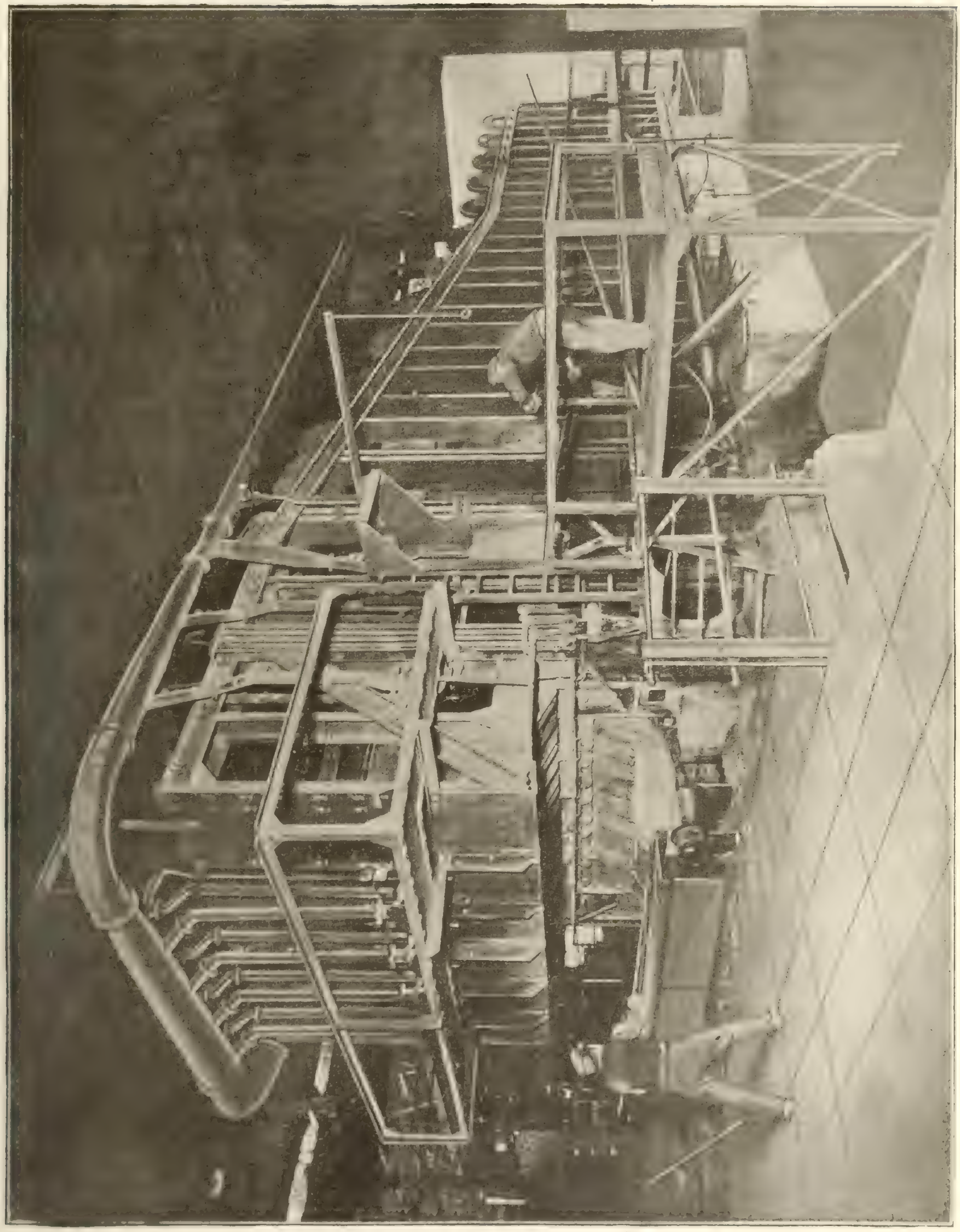


Figure 3.
Continuous Billet and Bloom heating Furnace.

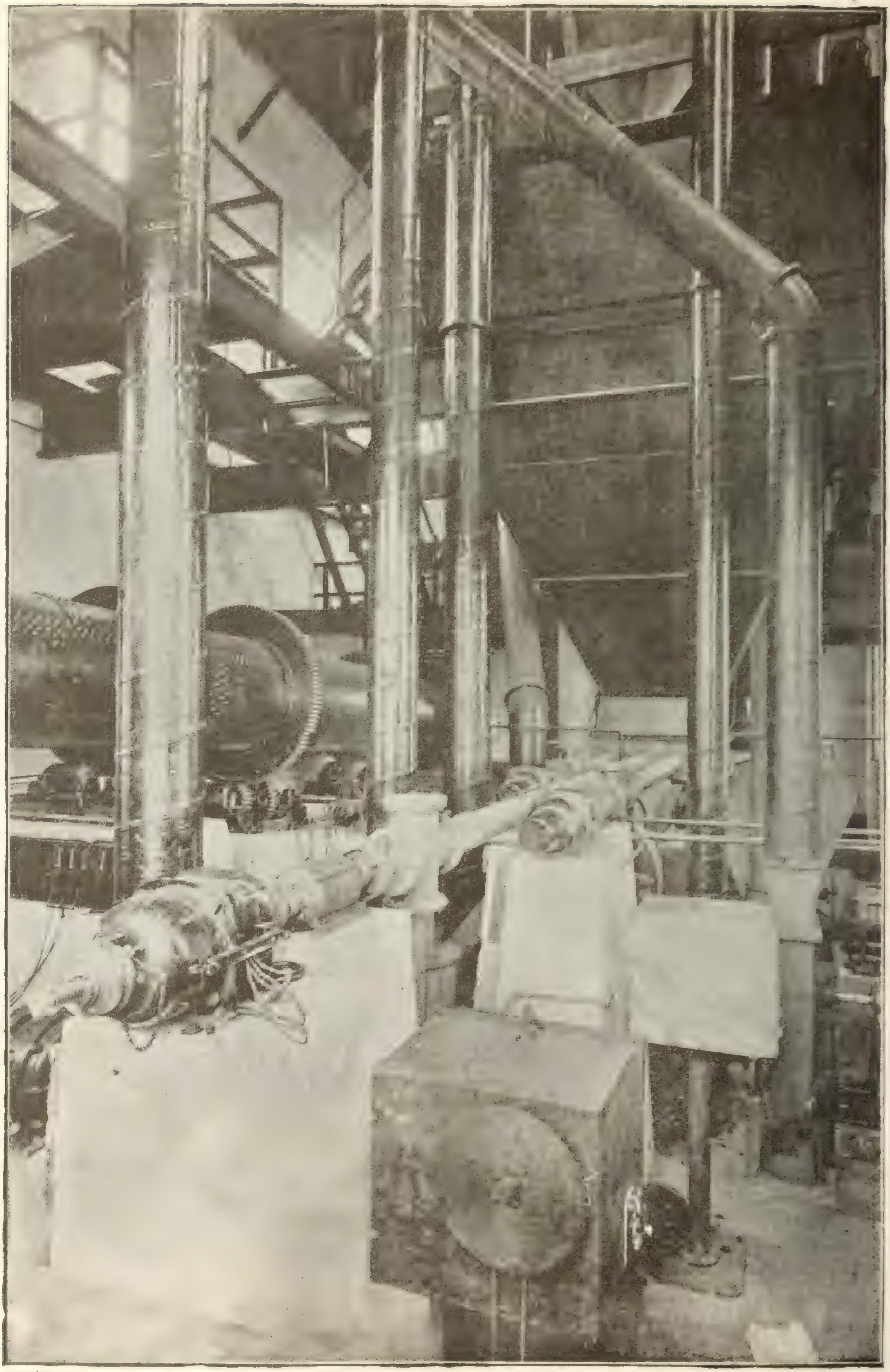


Fig. 4.
Distributing mains for powdered coal.

The distributing mains are asphalt coated, spiral rivetted pipe of standard thickness with bolted joints, and this has proved to be an excellent medium for distributing powdered coal.

Figure 2 shows a row of annealing furnaces using powdered coal. The upper pipe is the coal dust distributing line, while the lower pipe is the secondary air line. Both lines of pipe have valves placed close to the mains with chains so they can be operated from the floor. These furnaces are used to anneal malleable castings in wrought iron boxes.

Pyrometer readings taken on these annealing furnaces show a uniform temperature of 1600 degrees F., while the variation for the week's annealing is from 1600 to 1640 degrees F. Natural gas required 20 to 25 hours to bring the furnaces and charge up to 1600 degrees F., but with powdered coal it was found that this could be done in 12 to 15 hours. The size of the furnace is 9′—8″×18′—0″×7′—6″ deep. It is equipped with two powdered coal burners which burn approximately 80 pounds of coal per hour to maintain a temperature of 1600 degrees F. in the furnaces.

The total fuel cost per month to operate these furnaces was found by actual tests on a comparative basis, to be as follows:

Natural Gas, 14,000,000 Cu. Ft. at $.35 per thousand	$4,900.00
Fuel Oil, 105,000 gallons at $.08 per gallon	$8,400.00
Powdered Coal, 525 tons at $5.00 per ton, which includes labor, power and maintenance	$2,625.00

The cost per ton for labor, power and maintenance are made up as follows:

Power, for crushing, etc., 30 to 40 kilowatt hours.

Labor, 25 cents.

Repairs and supplies, 5 cents.

There is no cost for handling the coal at the furnace, as the supply of coal and air is controlled by valves, but there is a small charge for cleaning out the ashes at the end of each week.

Figure 3 shows a continuous billet and bloom heating furnace which has been using powdered coal as a fuel for the past two years in a large steel mill near Harrisburg, Pa. This furnace is approximately 15 feet by 52 feet long and will heat 100 tons of 4″×4″×55″ billets in 12 hours, charged cold. Another furnace of the same size and design will heat 217 tons of 8″×8″×10 feet blooms in 12 hours, charged cold. The powdered coal consumption on these furnaces will average 100 pounds of coal per ton of steel heated.

A powdered coal plant of the Holbeck preparing and distributing system has been installed at the Armstrong Whitworth Company of Canada, Ltd., at their works at Longueuil, Quebec, by the Bonnot Company, Canton, Ohio. At this works the powdered coal is used for the rolling mill furnaces for the hammer shop, for the open hearth furnaces, for the new car wheel and locomotive tire shop and for their four 500 H.P. boilers. There are in all four (4) complete separate systems for the different furnaces and all these are supplied from one powdered coal plant.

Figure 4 shows one of the locomotive tire furnaces at the Armstrong Whitworth Co., having a 250 H.P. Goldie and McCulloch waste heat water tube boiler placed on top of the furnace. The waste gases pass from the furnace up into the boiler and out again at the stack; the two powdered coal burners are located at the same end of the furnace.

This furnace is used for one of the three heating operations required in the making of locomotive tires. It burns about 450 pounds of coal per ton of steel ingots, and heats approximately 28 tons per 12 hour turn. Meanwhile, the boilers are developing about 125 H.P. per hour, without any additional fuel.

As a boiler fuel powdered coal is doing all that was expected of it, and it is not unusual to get a factor of evaporation of 9 to 11 and even 12 pounds of water per pound of coal burned. The ash being pulverized with the coal does not adhere to the tubes, but passes up the stack along with the waste gases, while the slag or heavy particles of ash is deposited in the combustion chamber in the form of slugs or molten slag, which can be easily tapped out. The tubes require cleaning about once in six hours, and this takes a man from twenty to thirty minutes with either a steam or air soot blower.

The most desirable feature, however, in the use of powdered coal under boilers, is the ease with which sudden calls for extra load on the boilers are taken care of, simply by opening the coal dust valves and secondary air gates, when the boiler immediately responds and the pressure jumps up. On the other hand, if the load drops off suddenly, the opposite result can be obtained by closing the coal dust valves and secondary air gates.

With powdered coal the standby losses are practically nothing, as the boiler can stand completely shut down for a period of ten hours with the coal dust valves closed and all the dampers shut. At the end of this time there will be enough heat in the combustion chamber, to ignite the powdered coal immediately on opening the valves.

MENTAL FACTORS IN INDUSTRIAL ORGANIZATION.*

(By THOMAS T. READE, M., Ph.D., New York, N.Y.
(New York Meeting, February, 1919.)

*Report of Chairman of Institute's Committee on Industrial Organization.

Readjustment of the industrial world to a peace basis after more than 4 years of war will involve many fundamental and far-reaching changes that cannot as yet be clearly foreseen or definitely provided for. Such problems may, in the vocabulary of war, be subdivided into those involving material and those centering about personnel. Of the two, the latter group is the more difficult and obscure, as the factors involved are less clearly understood and the methods to be followed are not yet tested and standardized. When it is said that the market is weak, stocks large, and the demand light, every business man understands clearly what is meant and what course he should adopt to adjust himself, so far as possible, to such conditions. But when it is said that the rapid spread of Bolshevism in Europe is a danger to industrial organization in this country, it is difficult to have any assured sense that all that the statement may mean is clearly understood or that the means to be followed to meet such a situation are definitely known. Since Bolshevism is primarily a mental phonomenon, and since the rupture it brings about in industrial organization should be prevented, if possible, it is my purpose to restrict this discussion

of the activities of the Committee on Industrial Organization to some of its mental aspects, as the chairmen of the sub-committees, from their special knowledge of their own fields, can best set forth recent progress in the lines with which they are especially concerned.

The first requisites of success in industrial organization, as in the biological organism of which it is the social counterpart, are unity of purpose and co-ordinated activity. Typical good and bad examples of this are the relative parts that the United States and Russia have played in the great war. These two factors are primarily mental, and it is not difficult to view the mental aspects of all problems of industrial organization as the most important ones. Unless we can attain unity of purpose and co-ordinated activity in industry, the provision of comfortable homes at reasonable rent, the assurance of steady work at good wages, the elimination of industrial accidents, and provision against want in old age or in case of disability will have brought us no nearer to our real goal.

An industrial organization is made up of three groups: those who furnish the capital and take the risk of the enterprise, but frequently have little active part in it after it is firmly established; those who represent the first class in the active direction of the enterprise; and those who give their energies for an assured wage, without assuming any of the risk. Some of the reasons why these three elements find it difficult to achieve unity of purpose and perfectly co-ordinated activity are indicated below, in the hope that their statement in this brief form will draw forth helpful discussion.

Activity of any kind, up to the fatigue point, is agreeable to any human being, if it has an adequate motive and offers an opportunity for self-expression. Under such circumstances much effort may be put forth and great discomforts endured with equanimity. A good example of this is duck-hunting; very few people care to spend more than a few days in this form of activity, for the motive declines in relative importance and the discomforts relatively increase. Under most forms of industrial organization, the workman has little motive for labor, beyond the wage offered; his opportunity for self-expression comes in the character of the work done. The growing complexity of industrial processes due to research, and the immigration to the eastern United States of large numbers of workmen of relatively low intelligence, has lead to the development of the functional, or so-called scientific, system of management. This method was developed by F. W. Taylor, as the best way of supervision of men of inferior grades of intelligence. Its great drawback when applied to workmen of higher intelligence is that it almost completely robs them of the few opportunities for self-expression in their work that remain under the modern system of assigning only one operation out of many to an individual. The management still finds its motive and self-expression in putting on the market a product that can be sold at a good profit, but the workman is too remote from this to feel any satisfying part in it, although the industrial value of an established brand or trademark must not be overlooked, since the workman finds some satisfaction in laboring to turn out a product of recognized merit. Safety work has accomplished some good along this line by what is known in psychology as deflection; the workman does a standard amount of work without any accident and finds his opportunity for self-expression in the latter feature of it. Company baseball teams, bands, first-aid teams, and similar activities that enable the individual employee to express his personality are of value. But the net result of the present tendency in industry is for the workman to see in his work only the unpleasant necessity of earning a living and to find his mental satisfaction in other forms of activity. This is putting the cart before the horse; it is just as though the army went to defeat the enemy only as an unpleasant necessity and found compensation for its sacrifices in something else. The various profit-sharing schemes that have been devised are only a makeshift and do not introduce the workman as a partner into the enterprise in the sense that his motive becomes identified with that of the organization. The fundamental fact remains that the workman is not in a position to take much risk and how he can be made a partner in industrial enterprise without sharing its risk in an unsolved problem.

The wonderful possibilities of an adequate motive and properly co-ordinated activities has been indelibly impressed on every business man who visited the training camps of our National Army and saw the results accomplished in a few months' time with what must have been slightly below average human material, since many of the most effective men secured industrial exemption. No one who has seen it can forget the tense eagerness of both officers and men. An industrial organization that could inject anything like the same spirit into its personnel would be, like our army, invincible. Co-ordination of activity depends on leadership; identification of motive in industrial organization is impossible unless the principle is admitted that the opinions of the laboring members of the organization are entitled to a respectful hearing and consideration on their merits.

Underlying these general considerations are the mental characteristics of the individual workman. Perhaps the most significant of these for our present purposes is the necessity to the individual for rationalizing his acts, or the assigning to them of a motive that is satisfactory to himself. A man, for example, strikes another who has insulted him, not because he is angry, but because honor requires it; or he refrains from striking him, not because the other is too large to strike with impunity, but because it would be too undignified to do so. In this way the most unworthy acts can be put on high moral grounds. Sabotage is a typical example of this in industry. The mental reaction in a man who can make only a poor living by hard work and is confronted with the easy success of others more fortunate is too apt to be one of jealousy and in the end produce the adoption of a "What's the use of trying" attitude. We all talk of equality of opportunity and have too much tendency to overlook the fact that it is largely beyond the control of ourselves or anyone else. Two soldiers of equal merit may be assigned to the infantry. One gets into battle, captures an enemy gun, escapes unhurt, is decorated, returns in triumph, and is elected mayor of his home town. The other contracts pneumonia and dies in a field hospital. Up to the limit of human control both had equal opportunity. It is admitted that both were of equal merit, yet the reaction many of their colleagues will exhibit, is sympathy in the one case and a feeling that "I could have

done it better if I had had the chance" in the other. When with this latter feeling is coupled a tendency to rationalize a wrong course of action, the individual becomes very badly adjusted to the circumstances under which he must live. A rough definition of a Bolshevik would be a person who is dissatisfied with things as they are, and is able to rationalize a course of action that experience indicates will make them worse instead of better.

The next point to be here considered is that efficiency is in large part a question of mental adaptation. Dr. Yerkes is to present to our membership an account of the methods that have been developed under the auspices of the War Department to determine the relative intelligence of men as an indication of their fitness to become officers. The trade tests developed by the same committee are of even greater interest in industrial organization. Capital has become too cheap and human effort has become too dear to admit much longer of the time-honored method of trial and error as a means of fitting the job to the man. The man who is not fitted to his job is constantly having the ground cut from beneath his feet by discouragement and discontent, two arch enemies of efficiency. The greater part of progress along this line has yet to be achieved, for we have made only a beginning as yet.

There are many other normal mental factors that might profitably be discussed, but they must be left for consideration at another time in order to pass on to the second half of this subject, the relation that mental abnormalities bear to industrial organization. It is now definitely known that some people exhibit throughout their lives mental abnormalities and others exhibit them at times. The paranoics form one group. If these are of the depressed type, they are surly and suspicious, believe themselves to be unjustly treated, and fail to appreciate any kindness shown them. The Kaiser has been described as an example of the exalted type, persons who believe they are benefiting others while making infinite trouble for them. Another definite group comprises the emotionally unstable, who show a tendency to brood and be unhappy, but are modest and self-effacing. They are always ready to undertake anything new, but tire of it before it is completed. They are marked by the violence of their reactions to slight provocation. It is definitely known that these types are present in industrial organization, but neither their numbers nor their effect on the normal psychology of the organization has yet been ascertained. In addition to these permanently abnormal people are those who are temporarily deranged. People who cannot stand worry, overwork, or other unfavorable conditions give way mentally and one-fifth of those admitted to insane asylums each year are of this type. Most of them later get well. There may be hundreds of thousands of cases of mental disturbance of this kind that do not reach the point of requiring admittance to the asylum, just as a man may have a severe cold but not go to the hospital. It seems reasonable to suppose that the paranoics may have a large effect in breaking down unity of purpose and co-ordination of activity in a normal body of workmen and that the emotionally unstable may play a large part in inciting the violent outbreaks that sometimes attend industrial disputes. Since mental abnormalities of this kind are relatively more common among people of marked ability than among the mediocre, it is hardly necessary to add that mentally abnormal persons may be found in the management as well as in the working force. It is the hope of this committee that it will be able to do some pioneer work in ascertaining the prevalence of the mentally abnormal in industry, determine the actual effects, what means should be taken to minimize the bad effects and to utilize whatever possibilities there may be for good to the fullest possible extent.

FORGE SHOP AND HEAT TREATING ECONOMIES.

The coal fired furnace and the custom of buying an oil burner and putting it into a box-shaped furnace are both historical events in the modern shop.

When fuel oil was to be bought for two or three cents a gallon not much thought was given to the question of economical burning in oil-fired furnaces; but during the production period of munitions the price of oil at from twelve to fourteen cents made it imperative to consider the careful application of this material.

Neither of these prices obtain to-day, but oil is at a figure where the economical furnace is necessary and the results of experiments carried out during the war are of great advantage.

To secure furnace efficiency there must be co-ordination of burner and furnace design. This is overlooked by many of the manufacturers of oil fired furnaces, and frequently one will see furnaces in operation where a very large percentage of the flame is escaping through the vent flues.

Design of Burner and Furnace.

In order to offset this, the burner, or to give it its proper style "the mixer," must be designed in such a manner that the air and oil are properly mixed, so as to form atomised gas before it enters the furnace. Not only must the burner be so carefully attended to, but the furnace itself must be so designed to carry on the process of vaporization before the flame reaches the metal to be heated.

The Canadian Incinerator and Furnace Company, Limited of Toronto, have developed a furnace and burner which together meet the requirements stated above. The air and oil are properly mixed by the burner and the furnace is so designed that the final splitting up of the oil into a gas is accomplished. The process is the result of exhaustive experiments with actual furnaces in operation assisted by laboratory research. A thorough investigation of the mechanical application of fuel oil was made, and it was found that the more nearly a gaseous state of the oil could be approximated the better the results obtained and the more economical the consumption of oil.

Control of Air.

It is essential also to maintain perfect control of the amount of air necessary to support combustion as an excess of air leads to oxidation of the metal and scale. Excess air also reduces the temperature of the furnace and hence adds to burning costs. In this company's furnace the proper control of air supply is provided for by an adjustable blast gate.

A further economical feature in this furnace is the preheater, a patented device by which both air and oil are heated by the waste gases prior to entering the burner or mixer. The air and oil thus heated produced bet-

The Canadian Incineration and Furnace Co., Ltd., Toronto.

ter atomisation of the oil and almost immediate vaporisation. The resultant oil gas enters the furnace and is finally split up and ignited by contact with the impinging arch giving a perfect heat flame free from unconsumed oil and without any smoke whatsoever.

Furnace efficiency is kept at a high standard by the pre-heating of the air and oil, as no loss is incurred from heating the incoming air in the furnace proper.

Furnace Construction.

The furnaces are designed to meet the special requirements of the class of work to be heated. A stereotyped form of furnace is not possible where efficiencies are to be studied. However, there are certain general lines upon which this company produces its designs. The oil burner is made in different sizes, according to the dimensions of the furnace. Impinging arches and combustion chambers are essential to the design throughout. Flues or vents are arranged so as to ensure the equal and proper distribution of heat throughout the chamber, and when only part of the furnace is used such flues can be closed, so as to control the location of the heat to that part of the furnace in use.

Radiation Losses.

Radiation losses are reduced to a minimum by wall thicknesses, asbestos lining and steel casings. These casings are of steel plate properly supported and tied together by buckstays and tie rods.

Experienced firebrick masons only are employed, thus ensuring careful and accurate work, and reducing the heat losses by cracks, which would occur if workmanship were poor.

Efficiency Service.

The Canadian Incinerator and Furnace Company makes it a practice to co-operate to the fullest degree with the purchaser. Entire satisfaction is the guarantee of their product. The staff of engineers attached to this concern give full study to the particular requirements of the work the purchaser requires to do and the excellent records at the Dominion Shipbuilding Company's plant at Toronto, The Port Arthur Shipbuilding plant at Porth Arthur, only go to show that the furnaces designed and erected by them are proving entirely satisfactory.

This company also has partly completed furnaces for the British American Shipbuilding Co., Welland, The Davie Shipbuilding and Repairing Co. at Levis and The Halifax Shipyards Ltd., Halifax.

During the war, billet heating furnaces were built for the G. W. McFarlane Engineering Co., of Paris and John Inglis Company of Toronto. These furnaces were the means of increasing the output of existing oil burning furnaces at a very much reduced cost. The British Forgings, Limited, the Cluff Ammunition Co., The Canada Metal Co., Ltd., of Toronto, adopted this company's type of furnace after tearing out other types, and so increased their output at least 33 per cent.

A PROPOSED BOUNTY ON CANADIAN IRON ORE.

In February the Boards of Trade of Sudbury and Port Arthur memorialized the Government of Canada, asking for a bounty of not less than fifty cents per ton on all iron ore mined in Canada, such bounty to be in force for fifteen years, and paid monthly to mine operators. The bounty is asked on the tonnages treated, where treatment of the ores is necessary; and where treatment is not required, on the tonnages fed to the furnace.

The census compiled by the Dominion Bureau of Statistics for 1917 shows that the iron and steel industry of Canada now heads the list of Canadian industries. The total capital invested in Canadian industrial plants in 1917 was $2,772,500,000, while the capital invested in iron and steel and allied industries was $399,300,000. The gross value of the various iron and steel industries with the allied manufactures, during 1917, reached a total of $651,790,000, out of an aggregate gross value of goods made in the Dominion in that year of $3,105,507,000. Allowing for the expanded condition of the iron and steel and allied industries in 1917 consequent upon war orders, it is nevertheless evident that this industry has become a most important part of our national life.

The fly in the ointment is that out of 2,242,337 tons of iron ore charged to furnaces in 1918 only 96,745 tons was ore mined in Canada. Of the iron ore imported, 754,622 tons was Newfoundland ore, and 1,390,970 tons was "Lake ore" from the United States. The whole industry is therefore dependent on a source of supply situated outside the Canadian border, a situation that from a national viewpoint has disadvantages.

The occurrences of iron ore in Canada are large and well distributed, and are only partially explored. Lean ores, unkindly and refractory ores, and ores needing treatment before going to the furnaces are understood to predominate; but in iron ore, as in coal, values are comparative, and the utilization of a lean or unkindly ore will always be deferred if a rich and suitable ore is available. Poor ores become valuable when they are all a country possesses. The iron ore deposits of Canada have remained undeveloped because Lake ores and Newfoundland ores are cheaper and of better quality than known deposits of Canadian ore. From the strictly economic aspect it is not likely that Canadian ores will be largely worked until factors of scarcity and increased cost or decreased suitability in ores of outside origin manifest themselves.

From the strictly national viewpoint, however, another and a differing aspect presents itself. Economic dependence sooner or later must spell political subservience, and Canada can never be really secure in her political independence until she can produce iron and steel from her own coal and ores.

From the wider viewpoint of the Empire, the iron ore deposits of Newfoundland may be included in Canadian resources so long as the Empire retains sea-power, and, it may be remarked, that the value of the Wabana iron ore deposit to the Empire—while it most certainly has not escaped those who are guiding the policies of the Empire,—is not adequately appreciated by the public at large. The steel plants of the East need have no anxiety on the score of ore supply, for there is enough and to spare. The Wabana ore-deposit is a great British asset, and more will be heard of it as

the British peoples take up the ordered progress and unification of the family circle of democracies and wards, which constitute the Empire,- a- progress only temporarily interrupted by the recent eruption of the barbarians.

From the standpoint of the Government, the only objection to a bounty on Canadian iron ores would be the expenditure, and the Government has sufficient bills to pay just now without contracting unnecessary obligations. Admitting this point, however, it may be pointed out that unless the proposal to develop Canadian ores is economically sound, it will not be attempted, or, if attempted, it will not succeed. The amount the Government would have to disburse would in that event be negligible, whereas if the bounty is earned the resultant impetus to industry would far outweigh and would thoroughly justify the cost of the bounty.

Moreover, the Government, by approving a bounty of fifty cents per ton will not run the risk of making any capitalist richer, while it would display at least a desire to help Canada to become a little more independent in the matter of iron ore supply.

It is perhaps not realized how pitiably small is Canada's share of the iron ore output of the British Empire. The Imperial Institute of London has recently published a colored map of the world showing diagrammatically the chief sources of metals in the British Empire and the production in 1915. The figures for iron ore production are interesting, and thought-provoking. They are as follows:

	British Production of Iron Ore in 1915.
United Kingdom	14,235,012 tons.
Newfoundland	775,403 "
India	390,271 "
Canada	355,457 "
Australia	134,684 "
Total British output	15,890,827 "
World's output	150,000,000 "

Since these figures were compiled, Canadian iron ore production has declined to 206,820 short tons in 1918, while that of the United Kingdom and other parts of the Empire has increased, that of the United Kingdom remarkably so.

The really wonderful production of iron ore in the United Kingdom is a result of that country being thrown upon its internal resources, and it is surprising how much can be found at home when there is no other source of supply.

In a discussion which followed some remarks made by Dr. Goodwin before the Iron & Steel Section of the Canadian Mining Institute, relative to the unused titaniferous iron ores of the Dominion, it was admitted by practical furnace men present that the absolute unsuitability of titaniferous ores for blast furnaces use had not been demonstrated, because, owing to it being possible to obtain more kindly ores with facility, there had not arisen any apparent necessity or compulsion upon furnacemen to make serious experiments on an exhaustive and conclusive scale.

This about sums the situation up. Some spur, either of necessity or of gain is required to bring about the development of Canadian iron ore deposits, and, while we do not adhere to the popular belief that the Government is omnipotent and can work miracles, and would not wish to impose further worries upon an already overworked Cabinet, the question of granting a bounty upon iron ores mined in Canada should be most carefully considered by it, chiefly for the reason that if Canada is not a home producer of coal and iron ore, and all that depends upon and follows these basic industries, she is not thoroughly independent and self-sustaining.—F. W. Gray.

SUCCESSFULLY LAUNCHED.

The steel cargo steamer "Canadian Ranger" was successfully launched by the Canadian Vickers Company at Montreal on Saturday the 19th instant.

This is the fifth vessel to be launched in connection with the Government's shipbuilding programme, and three of these have come from the Vickers' yards. The "Canadian Ranger" was constructed during the winter, and every effort has been concentrated upon having her ready for launching as soon as the ice cleared. She has been built under special survey to meet the requirements of the British Lloyds 100-A1 clasification certificate.

The ceremony of launching was performed by Mrs. Orr-Lewis, the wife of the President of the Company, who has recently returned from England. A few prominent Montrealers were present, including shipping men, harbour authorities, and the company's principal officials.

The "Canadian Ranger" has a cargo-carrying capacity of around 8,100 deadweight tons; length overall 400 feet; breadth moulded 52 feet; depth moulded 31 feet; with 3,000 I.H.P. She will have a speed of 11 knots at sea.

(Continued on page 90).

The fact that Canada's leading shipbuilding plant is located at Montreal has naturally resulted in the people of this city feeling keenly interested in the forthcoming debate in Parliament in regard to the Government shipbuilding programme. The general opinion in circles where the experts foregather is that Canada can and should and must build ships.

It is argued that she can build them profitably; that she should build them to foster the new industry in which millions of dollars of capital and around 25,000 workers are interested; and that she must build ships to hold her place as a great manufacturing and agricultural country with a huge surplus to export every year.

It is not generally realized that something like four-fifths of the shipping using Canadian ports is owned outside of this country; and built outside of it. That means that the money spent in building them and the money they earn after they are built all goes out of Canada.

As to the argument of cheaper production; that is entirely exploded, when the question of the operation of the ships and the retention of the earnings in this country is taken into consideration. It is reported that it is not possible to place a contract in any British yard for delivery during 1919.

EDITORIAL

EDITORIAL CHANGES.

Dr. Alfred Stansfield and Mr. W. G. Dauncey have been joint editors of this paper from its first issue, in February, 1918, until the present number. The paper appeared at a time when the Iron and Steel Industry of Canada was making rapid progress, owing to the urgent need of producing shells and other munitions of war. At that time there was a keen interest in metallurgical methods and results throughout the Dominion, and the paper has been usefully engaged in placing before its readers the latest developments in the theory and practice of metallurgy, and the achievements of iron and steel workers from end to end of Canada.

The editorial staff represented, in a sense, the theory and the practice of iron and steel making, and they feel that they have had some measure of success in their endeavors to serve the Canadian public through this journal. They realize, however, that a paper of the importance of "Iron and Steel of Canada" cannot for long be conducted with entire satisfaction in the spare time of busy professional life, and in looking forward to the future development of the paper it seemed desirable to make a change and to secure the services of an editor who could devote his whole time to the work. Such a change has been made possible by the termination of the war, as capable men can now be spared, to some extent, from the operations of plants.

The removal of the printing office to its new quarters at Ste. Anne de Bellevue will eventually make it possible to render better service both in quality and despatch, but up to the present the removal has caused unfortunate delays, and has made the work more difficult and less satisfactory for the present editors. The new editor, residing in Ste. Anne's, will be able to carry on the paper with a minimum of friction and delay and a maximum of product and despatch.

The new editor, Mr. J. W. Gray, was educated in England. He received his practical training as a Mining Engineer under Mr. G. Blake Walker, who is now the President of the Institution of Mining Engineers, and his theoretical training at University College, Sheffield, from 1897 to 1899. Mr. Gray came to Canada in 1904, and was Chief Clerk of the Dominion Coal Company at Glace Bay until 1915, when he moved to Sydney, becoming Assistant to General Manager of the Dominion Steel Corporation. In July last, in consequence of Mr. D. H. McDougall's new appointment, Mr. Gray went to New Glasgow as Assistant to the President of the Nova Scotia Steel and Coal Company.

Mr. Gray is a member of the Institution of Mining Engineers, and of the Midland Institution of Mining and Mechanical Engineers. He is a member and ex-Councillor of the Canadian Mining Institute, and Editor and member of Council of the Mining Society of Nova Scotia.

Mr. Gray's writings include: "Coalfields and the Coal Industry of Eastern Canada" (Mines Branch, Ottawa, 1915); "Mining and Transportation" (Dominion Coal Company, 1908); contributions to the transactions of Mining Societies on mine rescue apparatus and miners' diseases. He has made frequent contributions to technical periodicals on questions connected with the coal and steel industries; was the Nova Scotia correspondent of "Colliery Guardian" (London) for twelve years, and of the Canadian Mining Journal since its inception.

During the time Mr. Gray spent in Nova Scotia he has been closely connected with labour matters; he was present at many labour conferences during the last fifteen years, from the wage agreements with the Provincial Workmen's Association in 1904, to the recent union of all the miners' unions of Nova Scotia with the United Mine Workers of America.

He has always been keenly interested in all matters pertaining to the social welfare of workmen, such as the formation of miners' relief societies, and also in the organization of mine rescue stations and "first aid work." At the Scotia plant he was in charge of the "Department of Industrial Relations," which includes the supervision of emergency hospitals, rest-houses, relief and compensation matters.

The industrial world is in a state of suspense at the present time. Industrial progress, and civilization itself, depend on co-operation between labour and management. If either of these assumes an irreconcilable attitude, industry will cease and our civilization, founded on industry, must collapse. The new Editor has had a wonderful opportunity of studying the needs of the workers and the ways in which harmony between workers and managers may be attained. Harmony amongst the workers is more vital to the Iron and Steel Industry to-day than any process or method of operation, and we feel confident that Mr. Gray, through the editorial columns, will afford very material assistance to the Canadian Industry.

In this issue we publish a brief statement concerning the Iron and Steel Industry in Australia. As an experiment this venture will be closely watched, for there are certain features of peculiar interest and importance. Taking a line through Port Jackson (Sydney), as a base and running about 78 miles north, about 100 miles south, and 105 miles west the great coal bearing arc of New South Wales will be enclosed. Inside this area there are several deposits of iron ore that would pay to develop; amongst these may be included Albion Park, Dapto, Wallerawang and Mit-

lagong. On most of these sites coal and limestone exist, and where this is not the case the three essential materials, coal, iron ore and limestone are within easy distance of each other. These potential assets have been known for many years, and most of them are in direct railway communication with Newcastle, the great coal mining area of Australia, and from where eighty per cent. of the exported material is shipped. The greatest distance between any one of these deposits and Newcastle is not more than 300 miles, and yet, ignoring the Lithgow venture of Messrs. G. & C. Hoskins, we have the first comprehensive effort to establish the manufacture of iron and steel in Australia inaugurated under a scheme whereby the iron ore has to be transported to upwards of 2,000 miles. The official opening of the plant, which is situated at Port Waratah, took place on June 2nd, 1915. It will thus be seen that the only experience gained has been under war time conditions, and it remains to be proved how the venture will fare from an economical aspect, when normal working is established. With one blast furnace and four stoves the first unit was installed and arrangements were made for duplication whenever business justified such action. Three open-hearth furnaces of 65-ton capacity are worked on the "direct process," and under basic conditions, for the ore derived from the present supply contains too high a percentage of phosphorus for the production of acid steel. The usual provisions for soaking and handling ingots preparatory to their introduction into a 35-inch geared mill were all of the latest design, and the plant could be classed as modern and up-to-date. The present installation is estimated to produce about 10,000 tons of pig iron per month, the bulk of which is being utilized for railway work, principally 80 lb. rails, but arrangements have been made for rolling all sizes of constructional sections from a 3-inch by 3-inch angle to a 24-inch rolled beam. At a later date a plate mill is also contempated. The coke ovens, a set of 66 Semet-Solway by-product recuperative type can produce between 300 and 400 tons of coke per day, and it is estimated that the fuel consumption of the present unit will be around 300,000 per year. The future development of this plant will be of the utmost importance to Australia, with nearly three million miles of area, with railways still in their infancy, and with New Zealand, Tasmania and the Pacific Islands as a market there should be an ever-increasing demand for iron and steel products. The inexplicable action of the sponsors in going so far for iron ore must of necessity prove a severe handicap, and it is probable that deposits closer home will soon have to be developed. The site of the works at Port Waratah is adjacent to an abundant fuel supply, but limestone must be brought from some distance; at the present time that from the Manning River is being utilized, and this deposit is one hundred miles north of the works. With ore transported by rail and water for 2,000 miles, and limestone one hundred miles away, one wonders why some of the other iron deposits were not selected and developed. New South Wales possesses ample ore, and in most cases the limestone is on the same property or easily adjacent thereto, and in no case is coal more than 300 miles distant. The great coal deposits of Australia, as far as is known, lie within a radius of little over one hundred miles of Sydney, and the time will surely come when local ore beds will be utilized to the exclusion of those of South Australia, more particularly as most of them could be used for conversion into acid steel. Victoria is not known to possess iron in any payable quantity, but coal is worked in the Gipps land forests, about fifty miles from Melbourne. On the north coast of Tasmania there are two fine deposits of ore, one very pure, and one containing around 5 per cent of chrome, but no coal, excepting a negligible quantity at Fingall, on the west coast. New Zealand has fair ore at Para Para, and other places, and an enormous deposit of titaniferous iron sand on the Taranaki beach. This material is practically identical with some Canadian deposits, but has never been worked in any way. We shall continue to watch the Australian venture with interest, for unless a heavy duty, or some form of bounty, is to be established we cannot see how the business can be financially successful, notwithstanding the distance between the Dominion and its nearest competitor.

The American Iron and Steel Institute held their meeting at New York on the 23rd and 24th inst., and we shall be in a position to deal with the proceedings in next month's issue of this journal.

MANGANESE DEPOSITS AT COWICHAN LAKE.

G. C. Mackenzie, who examined the manganese deposits at Cowichan Lake, Vancouver Island, reports:

The ore-body appears to be associated with the quartzite rocks of the Sickler series and consists of manganite and possibly some psilomelane which has undoubtedly been derived from the alteration of rhodonite, the silicate of manganese, which is strongly in evidence on both sides of the ore-body. Samples taken across the widest portion of ore with a metallic manganese content of better than 50 per cent, and with less than 15 per cent of silica, Prosphorus was found to be present in amounts generally less than .075 per cent.

Unfortunately, the owners contented themselves with merely stripping the surface, and while they have disclosed a very attractive outcrop of high grade metallurgical ore they had not during 1918 accomplished any cross-cutting or sinking to prove the quality of the ore depth. This, of course, is to be regretted, as in all secondary deposits of this nature, particularly of manganese, the deciding factor as regards the value of the deposit is the extent to which oxidation of the original mineral has taken place. That the owners realize the importance of this is indicated by the fact that they are now engaged in removing portions of the outcrop to prove the quality of the ore for at least ten feet below the surface.

If the Cowichan deposits are proved to contain a large tonnage of metallurgical ore such discovery would be of considerable importance to the iron and steel interests of this country. At the present time, Canadian iron and steel works are using something over 1,000 tons monthly of ferro-manganese, all of which is imported either from England or the United States, and therefore if a domestic supply of manganese ore can be assured its utilization should be carefully investigated. The situation of the deposits with respect to the market in Eastern Canada is unfortunate, and it is a matter of doubt whether it would be advisable to manufacture ferro-manganese on the coast, or transport the ore to Atlantic ports via the Panama Canal. — Mining & Engineering Record, March, 1919.

Die Casting and Their Application to the War Program

By CHARLES PACK,* Brooklyn, N.Y.

This is a reprint of a paper presented at the February meeting of the American Institute of Mining Engineers, held in New York.

Die castings may be defined as metal castings made by forcing molten metal, under pressure, into a metallic mold or die. It is necessary to keep this definition in mind to avoid confusing this process with other permanent-mold casting processes. The fundamental principles of the process have been known and practised many years. The simplest application is embodied in the modern linotype machine, in which molten metal (usually tin-lead alloy) is forced under pressure into a metallic mold. The pressure is derived from a piston and cylinder immersed in the molten metal. Progress in the art of die casting may conveniently be divided into three groups: Machine for imparting pressure to the metal material for the die or mold, casting alloys.

Casting Machines.

The problem of delivering molten metal under pressure into a die is comparatively simple, when dealing with low-fusing-point alloys, as the alloys of lead and tin, but it is much more complicated when dealing with metals of higher fusing points, such as the alloys of lead and tin, but it is much more complicated when dealing with metal of higher fusing points, such as the alloys of zinc, aluminum, and copper. Although the art of die casting is comparatively new and, to a large extent, unknown, the records of the patent office are replete with patents on the subject.

Fig. 1 shows an Underwood machine patented in 1902; this is probably one of the first machines designed for the production of commercial die castings. The relation of this machine to the linotype casting machine is clearly apparent. A cylinder and piston are immersed in the molten metal so the application of power to this piston forces the molten metal, under pressure, into the mold or die. The Doehler machine, Fig. 2, patented in 1907, is based on the same principles. This machine is used to a large extent at the present time, throughout the United States, for the production of zinc, tin, and lead alloy die castings.

*Chief chemist, Doehler Die Casting Co.

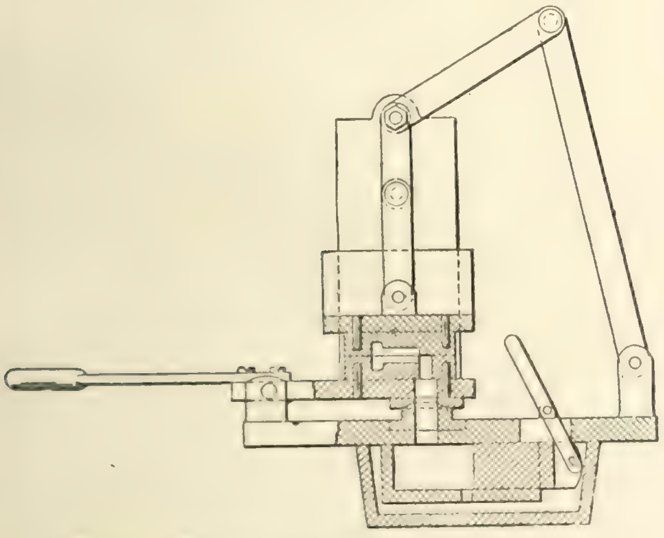


Fig. 1.—Underwood die-casting machine.

In the machine shown in Fig. 3, patented by Doehler in 1910, compressed air is used for forcing the metal into the die. In Fig. 4 is shown another of this type of machine. Here compressed air is applied to the surface of the molten metal to force it into the die.

In a machine patented by Chandler in 1914, shown in Fig. 5, the principle of the internal-combustion engine is applied for exerting pressure on the molten metal. A charge of gasoline vapor and air is injected into the melting chamber, the explosion of which

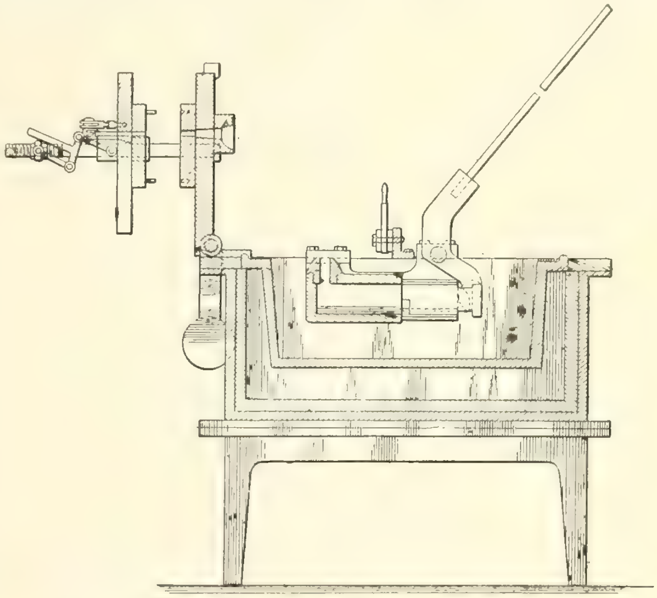


Fig. 2.—Early type of Doehler machine.

forces the metal into the die. The writer has never heard of this machine being used on a commercial basis, but it is mentioned to show the various means suggested for forcing molten metal into a die.

Methods Used to Avoid Blow-Holes.

The fact that die castings are made under pressure would suggest, on first thought, dense and homogeneous castings; this impression, however, is not in accord with actual practice. On fracture, the pressure die casting will be found to consist of a dense closely grained outer stratum and a porous inner stratum and a porous inner stratum. Blow-holes of varying size may be expected in the centre of the die casting, particularly through heavy sections. Many machines have been designed with the primary object of overcoming this difficulty and producing solid die castings.

Fig. 6 shows an air operated die-casting machine with the die inclosed in a vacuum chamber. The inventor evidently assumed that the only cause for blow-holes in the casting was the presence of air in the die. In Fig. 7 is shown another die-casting machine in which the vacuum principle is applied; here the vacuum is applied directly to the die.

The production of die castings free from blow-holes has been the most serious problem confronting die-casting manufacturers. At various times it has

been stated that processes capable of producing solid and homogeneous die castings have been developed. If all blow-holes in die castings were caused by air coming in contact with metal, the vacuum process would deserve consideration. That the presence of blowholes in some die castings are due to other and more serious causes, the writer will endeavor to prove.

In Fig. 8 is shown a cross-section of a casting that can be gated at A or B; in the best foundry practice the gate A would probably be used. The first metal that goes into the die will chill around the inner walls and take the form shown in the shaded portion. The gate may then become chilled before the inner portion has been filled; this will cause blowholes that no vacuum will eliminate. A similar effect will be produced if the metal was too cold at the time of casting. The writer has produced castings having only an outer shell, similar to that shown in Fig. 8, by limiting the amount of metal injected into the die to a quantity less than that required to make the casting. A similar result may be obtained by running the metal so cold that it will chill the thinner sections of the casting before the heavier sections are completely filled. Lack of pressure will produce the same result.

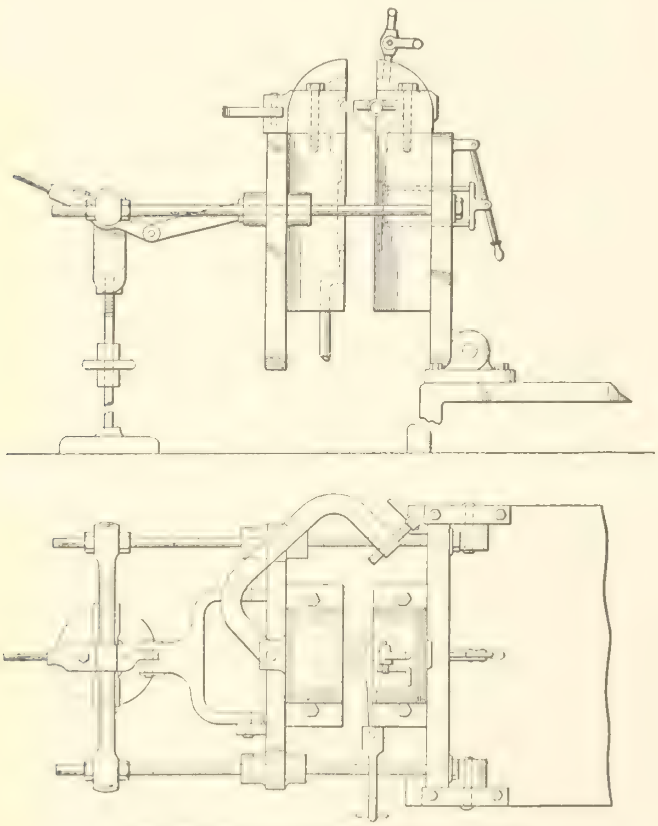


Fig. 3.—Doehler compressed-air machine.

Blow-holes in die castings may also be caused by the phenomenon that we sometimes call "piping." Makers of rolling-mill ingots have often been confronted with this problem. In Fig. 9 is shown cross-section of another casting gated at A. The metal flowing into the die at A will fill the entire mold cavity, assuming all casting conditions to be ideal, but the metal in the thin section adjoining A will chill before the heavier section so that, the chilling being from the outside, a shrinkage hole will be left in the centre. Here again no advantage can be gained by the use of the vacuum system.

Dies.

In the manufacture of die castings from zinc, tin, and lead alloys, dies made from low-carbon machine steel last almost indefinitely and answer every purpose. In the first attempts to die-cast aluminum,

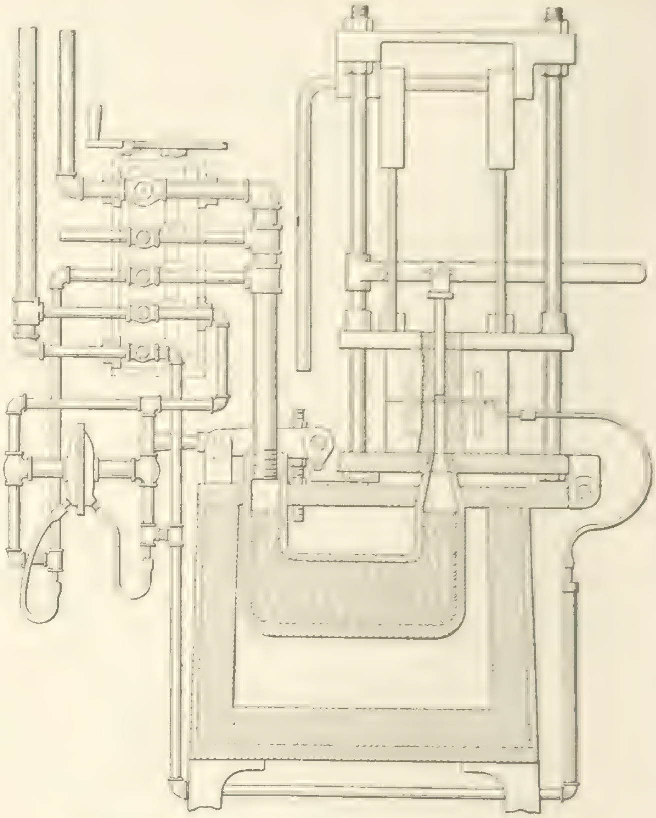


Fig. 4.—Another type of compressed-air machine.

the problem of obtaining a suitable die material presented serious difficulties, which were described by the writer in a paper read before the American Institute of Metals in 1915. This problem, however, has been solved by the use of various alloy steels so that the die casting of aluminum and its alloys constitutes the greater part of the die-casting industry of to-day. The proper gating and venting of these dies are problems that arise daily and on the solution of these problems depends the success or failure of the process.

Alloys.

In a paper read before the American Institute of Metals in 1914, the writer described the various types of zinc, tin, and lead alloys used in the die-casting process. The application of these alloys and their limitations were also pointed out. At that time the die casting of aluminum and its alloys was barely beyond the experimental stage. During the past 4 years, the most important advance in the art of die casting has been made in the perfection of the process for die-casting. aluminum and its alloys. The importance of this chievemetn as an aid to winning the war is demonstrated by the fact that at least 95 per cent of the die-cast parts used directly or indirectly as materials of war were made from an aluminum-base alloy. Of these castings, only a very small percentage could have been produced successfully in 1914.

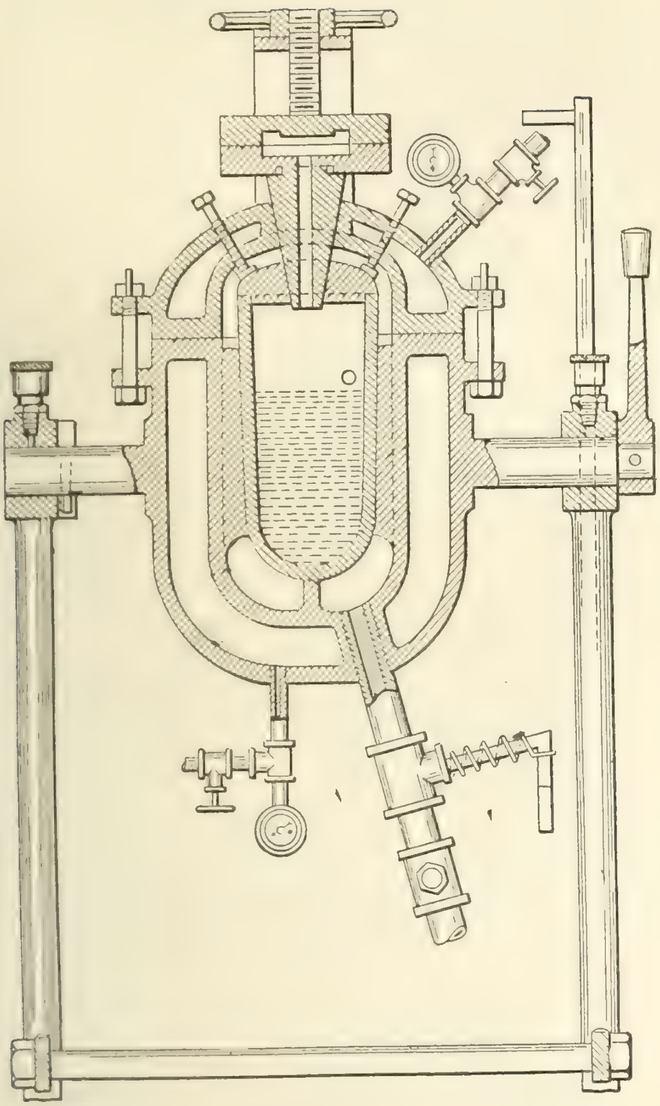


FIG. 5.—CHANDLER DIE-CASTING MACHINE.

Investigations of the casting properties of metals and alloys in the past have been generally limited to sand castings; few data are available as to the casting properties of metals or alloys in metallic molds. Just what constitutes a good die-casting alloy is a a subject of unusual interest. A few of the important requirements, outside of the usual physical properties demanded of alloys, are:

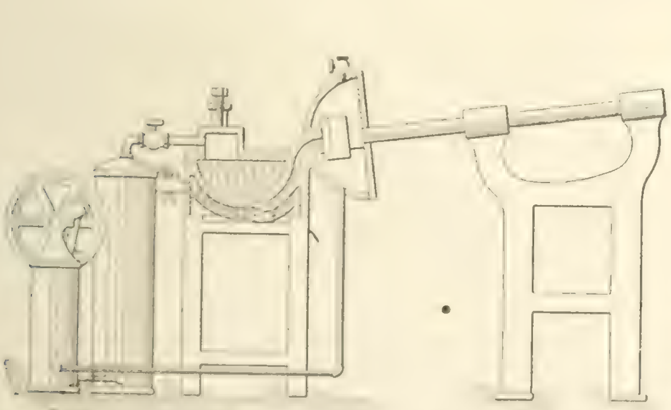


FIG. 6.—MACHINE WITH DIE ENCLOSED IN VACUUM CHAMBER.

Melting Point.—The successful die-casting machine in every instance is constructed of iron, in one form or another. The melting point of the alloy must be such that it will melt readily in an iron pot.

Solvent Action.—The solvent action of the alloy on iron must not be too great. Molten aluminum dissolves iron very rapidly and analyses of aluminum die castings on the market will show an iron content of from 1 to 3 per cent, due to the solvent action. Fortunately, there is no serious objection to the presence of iron in aluminum casting alloys. Should the aluminum absorb much above 3 per cent iron, the melting point becomes too high, and the alloy becomes viscous and unsuitable for making castings.

Elongation.—The elongation or ,to use a simpler term, the stretch of the metal is of vital importance in determining the die-casting properties of an alloy.

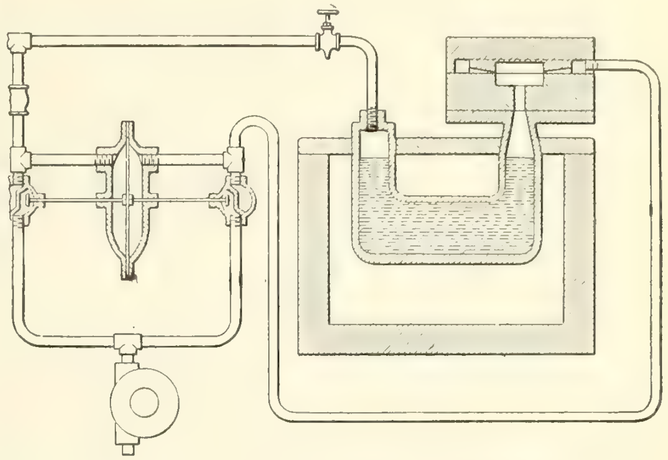


FIG. 7.—DIE-CASTING MACHINE WITH VACUUM APPLIED DIRECTLY TO DIE.

Not only is it desirable to know the elongation of the alloy when cold, but it is of greater importance to determine the elongation at various temperatures ranging from the melting point of the alloy down to normal temperature. The reason for this becomes apparent when the physical phenomena of the die-casting process are considered. Let us assume that a ring 12 in. (30.48 cm.) in diameter is to be die-cast in a metallic mold around a metallic core. As the molten metal strikes the mold it solidifies. Here a change of state occurs that is accompanied by a reduction in volume, commonly termed shrinkage. Unlike a sand core, the metallic core is not compressible and retains its original size and form so that the shrinkage of the metal is converted into a stretching action on the solidified casting. If the elongation of the alloy at that temperature is not high enough to withstand this stress the casting will crack. In the usual die-casting practice it is not practical to remove the casting from the die at the solidification temperature of the alloy. For example, the solidification temperature of the aluminum-copper alloys used in the die-casting process is approximately 1150° F. (621° C.). It has not been found practical to run the casting dies above a temperature of 500° F. (260° C.), which means that the castings are withdrawn from the dies at that temperature. It follows that the casting is subjected to another stretching stress after the casting has solidified and that is due to the contraction in volume that must occur when a casting is cooled from a temperature of 1150° F. to 500° F.

The writer has been unable to find any reliable method for determining the elongation of alloys at various temperatures. Many methods have been suggested, but they have proved of doubtful value. The simplest way is to use the old "try-and-see" method. To test the alloy, a casting is made in a die having a comparatively large core and thin wall. If the alloy can stand the casting stress, a perfect casting will be obtained, otherwise the casting will show bad cracks. Only a comparative result is obtained, but for everyday control it answers the purpose. However, a simple and reliable method for determining quantitatively the elongation of metals and alloys

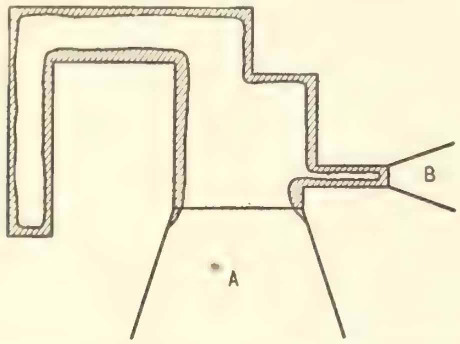


FIG. 8.—CROSS-SECTION OF CASTING WITH TWO GATING POSITIONS.

at various temperatures would prove of enormous value to all metallurgists engaged in the various phases of metal-casting research.

It is interesting to note that the elongation of a metal or alloy at normal temperatures is no indication as to the properties of that metal or alloy at higher temperatures. The writer has found many cases where an alloy showing little or no elongation at normal temperatures shows a high elongation at higher temperatures. The alloys of aluminum and copper may serve to illustrate this point. It is well known that the addition of copper to aluminum reduces the elongation of the aluminum alloy. An aluminum alloy containing 12 per cent copper will show less elongation than an alloy containing only 6 per cent copper when tested at normal temperatures. Nevertheless, the 12 per cent copper alloy has a greater elongation at higher temperatures than the 6 per cent alloy, and consequently the 12 per cent alloy is better able to withstand the casting stresses to which it is subjected in the die-casting process.

In the early days of the die-casting industry, alloys were compounded indiscriminately and little or no consideration was given to the metallurgical principles involved. The manufacturer in many instances knew much more about machinery than about metals. The result was that there were put on the market die castings made from alloys that deteriorated rapidly and created a prejudice among engineers against the use of these castings. That this prejudice was in part justified must be admitted; nevertheless, the modern die-casting plant is equipped with physical and chemical testing laboratories and the die-casting practice of to-day bears no relation to that of 5 years ago.

Die Castings Made for War Purposes.

Die castings have had their most severe test during the past 2 years, during which time most of the die castings manufactured were used directly, or indirectly, in the Government's war program. Here is a partial list of the application of die castings for this purpose.

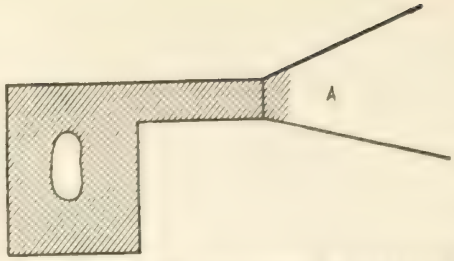


FIG. 9.—DIE CASTING CONTAINING SHRINKAGE HOLE.

Gas masks, breather tubes and other metal parts.

Lewis machine guns, 100 die-cast parts to every gun.

Browning machine guns, four of the most vital parts.

Naval and army binoculars, the entire housing.

Army trucks, tanks, and airplanes die-cast parts include parts of ignition system, carburetor, gasoline-regulating devices, steering-wheel accessories, ball-bearing cages, bearings, speed indicators, etc.

Pistol, complete signal pistol.

Submersible bombs, some designs contained as many as 10 die-cast parts. Hand and rifle grenades, every grenade manufactured in this country contained one or more die castings.

Trench mortar shells, plugs die cast.

Airplane drop bombs, one or more die-cast parts.

Surgical instruments, including hair clippers, respiratory devices, etc.

In many instances, die-cast parts were used where the failure of the part would result in serious loss of life. The fact that not one failure of a die casting has been reported must continue to be a source of deep satisfaction to the modern die-casting manufacturer.

THE CANADIAN VICKERS COMPANY LAUNCH ANOTHER GOVERNMENT STEAMER.

The steel cargo steamer "Canadian Seigneur," 8,400 ton deadweight, was successfully launched on the 7th instant from the Vickers' yards. Owing to the rapidity with which ships are being discharged from the construction berths at this plant the formality of an official ceremony was dispensed with. The "Canadian Seigneur" is the fourth vessel of the Canadian Government cargo ship programme to be launched from these works, and her dimensions are as follows:—

Deadweight carrying capacity (approximately)—8,400 tons.

Length (B.P.)—400 feet.

Breadth, moulded—52 feet.

Depth, moulded—31 feet.

I. H. P.—3,000.

Speed—11¾ knots.

The SS. "Canadian Ranger," which was launched by Mrs. F. Orr-Lewis, seventeen days ago, was at this time lying completed in the fitting-out basin, and it had been arranged for her to go up the harbour in a few days to receive her first cargo. The 7,500 ton deadweight cargo steamer "Samnanger," which was built in these yards last year has returned to port after making four voyages to Australia. This vessel was built to the order of Norwegian owners, but was handed over to Messrs. Furness, Withy & Co., who are still operating her.

Prevention of Columnar Crystallization by Rotation During Solidification

By HENRY M. HOWE*, and E. C. GROESBECK,[†]
Bedford Hills, N.Y.

This is a reprint of a paper presented at the February meeting of the American Institute of Mining Engineers, held in New York.

(A Contribution from Green Peace Laboratory.)

That the quiescence of a liquid while it is solidifying should favor the formation of columnar crystals, normal of the cooling surface, is seen readily on considering the mechanism of solidification.

First, each particle of any composite liquid, whether it be an aqueous solution or a molten metal, in solidifying splits up into two parts, different in composition and hence in fusibility. One part is infusible at the existing temperature, and hence solidifies, and in general attaches itself to the inclosing walls of metal which have already solidified A, Fig. 1. The other part is fusible at the existing temperature, and hence remains molten. In the case of carbon steel, the part of each drop which actually solidifies is poorer in carbon than the drop itself was before it began to solidify, and this impoverishment of the solidifying half-drop enriches the other half-drop in carbon, and thus makes it unfreezable at the existing temperature.

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[†] Bureau of Standards.

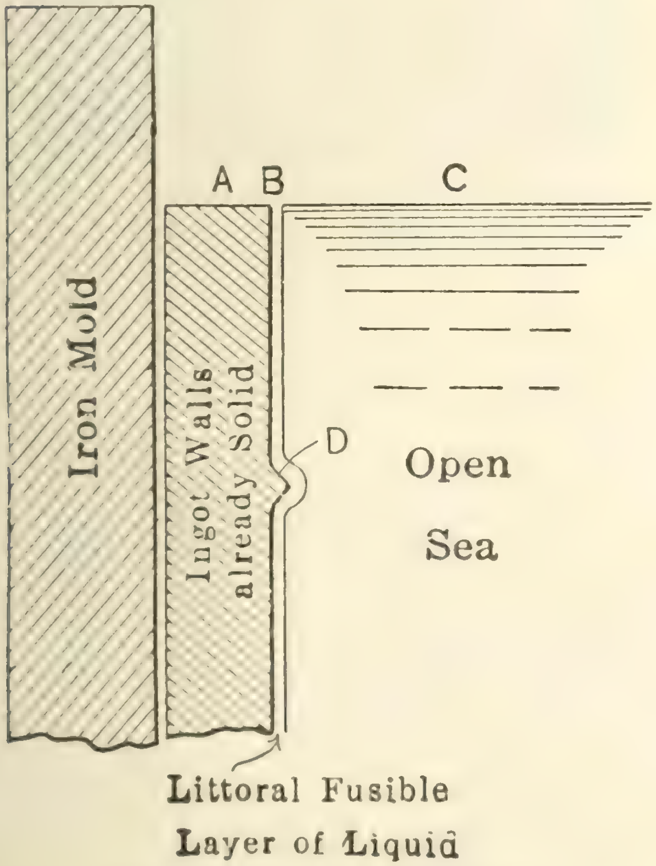

Fig. 1.—Mechanism of Solidification.

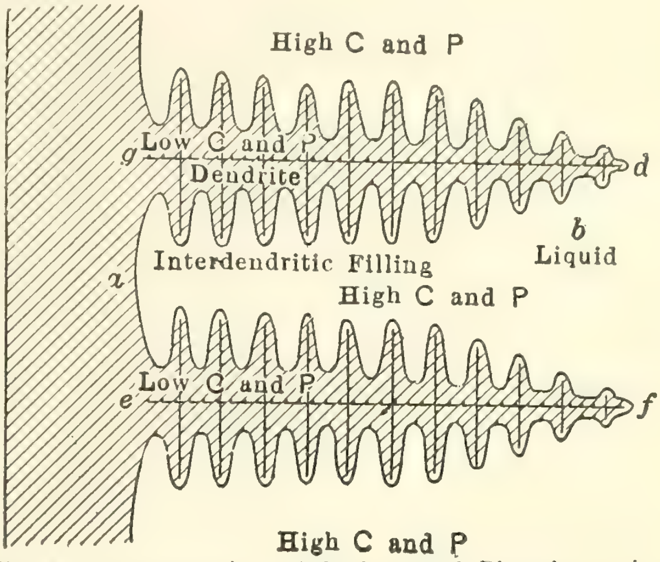

Fig. 2.—Concentration of Carbon and Phosphorus in the Filling Between Adjoining Columnar Crystals.

By this mechanism there arises during solidification a "littoral" or shore layer of liquid B, Fig. 1, bathing the already solidified walls, and more fusible than either those walls or the great remaining central mass of liquid or "deep sea" C, from which it separates them. It is essential that we grasp clearly this conception of a fusible littoral molten layer coating the already solidified walls and separating them from the deep sea.

Meanwhile heat is flowing rapidly outward through these walls, its escape cooling them, so that if any given particle of the deep sea metal could get past this littoral layer and come into contact with the solid walls, it would in turn solidify, and like its predecessors would split up in solidifying into a less fusible half-drop which would attach itself to those walls and a more fusible one which would remain molten. Thus we see that solidification can be continued only by some process of diffusion or convection, which will bring the freezable, because less fusible, deep sea metal past this fusible envelope which coats the solid walls, and into contact with them.

And this brings us to the columnar mode of crystallizing. Any projection, such as D, from the face of the walls will be reached earlier than the adjoining smooth unprojecting parts by the freezable deep sea particles. Further, each such projection increases its advantage over the neighboring smooth faces with every fresh addition to its tip. Moreover, this increment of advantage is continuous, and indeed continuously self-exaggerating. Growth at the tips of these projections in itself is the columnar growth

This sketch of the growth has been somewhat simplified by dwelling on convection as leading freezable droplets past the fusible and unfreezable littoral

layer of the molten mass. But what we have sketched as true of convection should be true of diffusion, which is probably more effective than convection in feeding the tips of the protruding crystals.

Having come thus far, we take the next step of recognizing that agitation, in that it tends to bring fresh freezable metal from the deep sea to the sides also of the growing crystals, thus diminishes the advantage which the tips have over the sides, and thus diminishes the columnarity of the growth. In particular, if we can keep the molten metal constantly sweeping past our supposed projections, it will in the first place sweep away the fusible littoral layer, and in the second place bring fresh freezable deep sea metal to the sides as well as to the ends of the columns.

The harmfulness of the columnar structure, especially if the columns themselves are coarse, is seen by considering a later stage of this growth, as sketched in Fig. 2. In the case of steel ingots, the splitting up which accompanied the solidification of each droplet rejects not only carbon, but also phosphorus into the littoral layer. If the parts of this which wash the sides of the columns are well landlocked, as in Fig. 2, this local concentration of the littoral layer in these elements will continue, and will progressively exaggerate itself as solidification progresses, leading at least to a marked local enrichment or segregation of these and other elements in the part midway between each pair of neighboring crystals. This is very

Fig. 3.—Upper Surface of Rotated Ingot, Showing Strong Spiral Markings. $\times$ 1.

harmful, because this segregate forms a brittle link in the chain, where rupture may occur under a shock which would fail to break the metal if it were uniformly distributed.

Continuously varying rotation during solidification should evidently be a very effective way of keeping the molten metal sweeping past the growing walls. This was proposed by Tchernoff[1] before 1880, and was carried out by Webb[2]. Tchernoff pointed out that the rate of rotation for this purpose should be as great as possible at first, and that its direction should be changed rapidly and violently.

Discussion on the Manufacture of Solid Steel Castings.

Webb[2] cast locomotive driving wheels thus, feeding the mold in the centre, while rotating it slowly at first, accelerating the rotation to about 40 to 50 revolutions per minute when the mold was filled, and then reducing the speed gradually. These two inventors almost certainly intended to prevent columnar crystallization by this means, though the mechanism of solidification was not known then. Our experiments carry out their forgotten and re-invented process.

In order to cause the continuous variation of rate of rotation, we set the vessel in which solidification is to occur on the horizontal disk of a common polishing machine, such as is used for preparing sections for microscopic examination. By holding the belt which drives this disk in the hands one can readily bring about a very rapid and continuous variation in the rate of rotation, by starting the rotation slowly to the right, clockwise, bringing it rapidly to

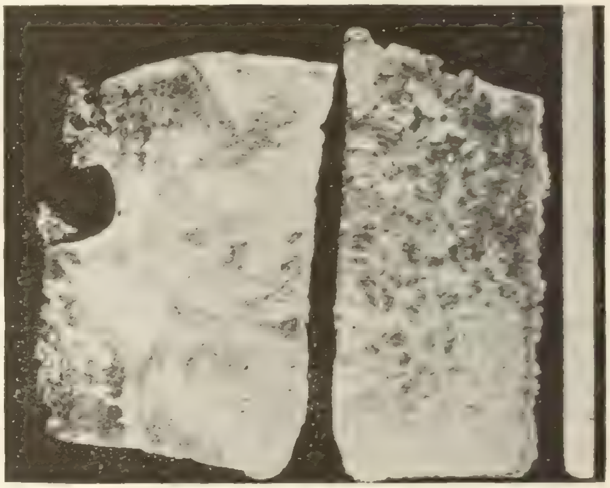

Fig. 4.—Stationary Ingot. $\times$ 1.
Fig. 5.—Rotated Ingot. $\times$ 1. About half of the Etched Vertical Section of Each Ingot is Shown Here.

a maximum and again retarding it and replacing it with contra-clockwise rotation. In order to show clearly the effects of this rotation, two like lots of the liquid or molten mass in each experiment were poured in immediate succession and in like manner into two like vessels, one of which was allowed to cool undisturbed while the other was rotated as just described. For brevity this method may be referred to as simply "rotation," which in every case varied continuously.

Experimental Results. — A strong hot solution of ammonia alum gave very much coarser crystals with quiescent solidification than with rotating solidification. Like results were reached with commercial zinc.

In order to introduce still greater differentiation during solidifying, we next tried a mixture of zinc with about 5 per cent of type metal, under the following conditions. The metal was melted in clay crucible under charcoal, was thoroughly stirred, and

[1] D. K. Tchernoff: Structure des Lingots Coules en Acier. Rev. Universelle (1880) (2) 7, 154.

[2] Jul. Iron and Steel Inst. (No. 2, 1862), 522.

was then poured half into a stationary iron mold and half into a like mold standing on the polishing disk, and rotating reversingly during pouring and for a long time after the upper crust had solidified. The conditions were as follows:

	Min.	Sec.
Poured into stationary mold at ..	0	0
Poured into rotating mold at ..	0	15
The upper surface of ingot in the rotating mold was completely frozen over at	6	55
The rotation was continued till ..	36	35

The strong spiral markings on the upper surface of the rotating ingot are seen in Fig. 3. Note how much more marked the columnar crystals are in the stationary Fig. 4, than in the rotated one, Fig. 5.

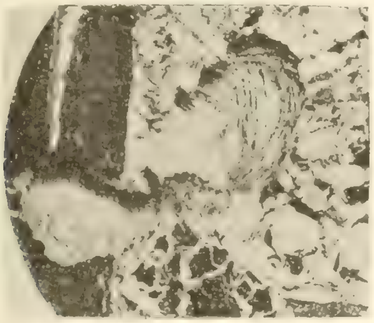

Fig. 6.—Furrows in Walls of Pipe in Stationary Ingot. × 1.6.

In every case in which the rotation was continued for a long time, results like these were reached. In one case in which the rotation was stopped soon after the upper surface had frozen over, no very marked difference between the stationary and rotated ingot appeared. This, we believe, was because most of the solidification occurred after the rotation ceased.

Fig. 6 shows the marked furrows in the central pipe, to the occurrence of which in steel one of us has already called attention.[3]

[3] H. M. Howe: Tans. (1907) **38**, 3-108.

IRON AND STEEL IN AUSTRALIA.

Mr. R. G. Casey of Melbourne, Australia, recently passed through Vancouver on his way home after spending the past four years in England.

Mr. Casey is chairman of the Mount Morgan Gold Mining Company of Queensland.

Of interest to British Columbia mining men, who look with strong hope to the Province having, at some early date, a smelter for iron ore, Mr. Casey's statement, that the Broken Hill Proprietary Co., of Newcastle, New South Wales, who have a silver zinc property, also own what is known as the Iron Knob in South Australia, where they produce iron ore which they haul 2,000 miles to Newcastle, where there is coal and deep water, and there have their smelter, which has been successful from the beginning, and they have shipped iron and steel to Great Britain during the war. The official year book published by the commonwealth of Australia, gives some interesting figures in this connection.

OF INTEREST TO THE PACIFIC COAST.

U.S. Shipping Board Begins Disposing of War Emergency Fleet.

Fifteen wooden steamships were sold to the Nacirema Steamship Company of New York for $650,000 each on April 17. This is an average of $145 per deadweight ton, and marks the beginning of the sale of the war-built merchant fleet.

Five of the fifteen vessels will be operated out of New York, five out of Havana and five out of New Orleans. The entire fleet will be operated by the Brooks Steamship Company of New York in the Transatlantic trade. Negotiations have been started by the purchasers of these vessels for the purchase of fifteen more of the same type.

Underwriters evidently regard this type of vessel as a good risk, as the Nacirema Company have obtained insurance ranging from 1½ to 3½ per cent. The original insurance rate ranged from 5 to 7 per cent.

The latest shipping board figures show 115 wooden ships in service. 703 vessels of this type were originally contracted for, but 214 of the contracts were cancelled after the armistice.

An expenditure of approximately $165 a ton is called for on contracts for wooden ships, which were let up to August 31, 1918. This is according to the shipping board's second annual report. By this, the sale of April 17 indicates a loss of $20 a ton from the cost production during the war, a total on the 67,000 tons sold at $1,840,000. Chairman Hurley has stated that a considerable writing off would be necessary in sale or operation because of the increased cost of material and labor during the war.

BRITISH COLUMBIA FREIGHT RATE ON PAR WITH UNITED STATES.

The United States shipping board rates of $12.00 and $14.00 have at last been accepted by the Vancouver shipping firms.

When the sudden drop from $30 to $12 was first announced local interest and independents attempted to bring about a more gradual decline, but were prevented by the law of supply and demand which has dictated the price of space on the boats.

On several Japanese liners there is subsidized space quoted lower than the shipping board rates and unsubsidized space has been offered as low as $10. Even at this some are holding back their goods in the hope that still lower rates may be obtained.

When rates were on the war basis of $100 per ton, the Japanese Government subsidized space on certain steamship lines for salt herring and all Japanese steamers had a subsidized rate for foodstuffs such as salt herring and salt salmon. The result was that many thousands of tons of salt herring were shipped last year from British Columbia to the Orient as herring is considered an especial delicacy in Japan.

SURPLUS METALS TO BE THROWN ON U.S. MARKET.

At a meeting held at Washington, D.C., between the officials of the Director of Sales Office, representatives of the lead and copper industries and of the Geological Survey it was decided to throw upon the market surplus stock of copper, brass and lead held by the War Department. This will be done gradually, however, in order that the prices may not be affected. Details are to be worked out later with a full representation of the producers concerned.

Electric Smelting of Iron Ores in British Columbia

By ALFRED STANSFIELD.

British Columbia Department of Mines, Bulletin No. 2, 1919.

(Continued from April number.)

APPENDIX VIII.

Type of Furnace to Use for Electric Smelting.

The furnaces that have been in commercial use or that seem suitable for the electric smelting of iron ores, are:

(1)—The Electric-Metals furnace used in Sweden;

(2)—The Helfenstein furnace tried in Sweden;

(3)—The Noble Electric Steel Company's furnace used at Heroult, California; and

(4)—The 3-phase open-pit furnace used for ferro-alloys.

The simplest of these is No. 4, the open-pit furnace. This furnace has no roof or cover, and has three electrodes, which are supported from above and are surrounded with the material to be smelted. The main objection to this furnace is that heat and gases escape from the furnace and are lost, besides creating a nuisance. As far as I am aware, this furnace has not been used commercially for smelting iron ores. Nos. 2 and 3 are like No. 4, except that the top of the furnace is closed in, thus lessening the loss of heat and enabling the gases to be drawn away through flues and used elsewhere for heating. Both these furnaces have been used on a commercial scale, but full particulars of their operation are not available. No. 1 is more elaborate than the others, and resembles an iron blast-furnace with an enlarged hearth. In this type, not only is the furnace closed to retain the heat and the gas from the smelting charge, but the gases are made to pass up a shaft, so as to heat and reduce the iron ore; being, indeed, returned again to the furnace for this purpose after escaping at the top. This furnace has been in successful commercial use for a number of years in Sweden, and some are now being built in other countries.

In this Appendix I give references to a number of descriptions of these furnaces, and compare the available data with regard to their operation.

I.—Electro-Metals Furnace.

An illustrated account of the furnace and plant at Trollhattan, entitled "Recent Progress in Electrical Iron-smelting in Sweden," is given by T. D. Robertson in Amer. Electrochem. Soc., 1911, Vol. XX, page 375. Full illustrated reports of the work at Trollhattan by J. A. Leffler, E. Odelberg, and E. Nystrom are given in Swedish in the Jern-Kontorets Annaler for 1911, 1912, and 1913. Translations of parts of these appeared in Iron and Coal Trades Review, June 9th and 16th, and November 10th, 1911, and May 2nd, 1913, Vol. 86, page 744. Articles entitled "Electric Iron Smelting" by Jens Orton-Boving appeared in the Canadian Engineer, December 18th, 1913, Vol. XXV., page 877, and in Iron Age, May 21st, 1914, Vol. 93, page 1269. The Swedish and other furnaces for the electric smelting of iron ores are described in my book, "The Electric Furnace," 1914 edition, pages 174-211, and in my report on "Electrothermic Smelting of Iron Ores in Sweden," Ottawa, 1915.

The following account of the Swedish furnace and process is from a memorandum by J. O. Boving, dated July, 1915:

"Reduction of Iron Ore."

"The methods and processes for obtaining pig-iron by electric reduction have mainly been worked out and put to commercial use in Sweden, but in a smaller degree the United States of America and Canada have contributed towards the experience gained. (Experiments have also been carried out in France and in Switzerland, but no commercial results have matured so far.) The reason for this is fairly obvious, as the development is based on the following cardinal conditions: Presence of cheap water-power and suitable charcoal.

"Sweden's iron trade has been based on the production of high-class charcoal pig since the earliest days of established industry, and it is chiefly on account of the high quality thus produced Sweden became famous for these products.

"Before the new processes of making steel in open-hearth and Bessemer converters were known, Sweden commanded high prices for her iron, but prices fell with the development of newer methods, and Sweden had to seek other ways in order to cheapen the cost of production and at the same time maintain the quality. Such means were found in the electric-reduction furnace. Sweden has an abundance of cheap water-power, and there are few countries in the world that have taken such beneficial advantage of it.

"The first electric-reduction furnaces were established in 1907. Now a great number of them are working and giving splendid results, as will be seen below.

"In Russia there are large districts where the conditions are similar to those in Sweden, and I am strongly of the opinion that developments could as profitably be made in the Urals, and maybe also in the Caucasus. The iron industry is already well established in the Urals. The ore is good. There is an abundance of water-power which would be easy to harness, and the supply of wood for charcoal is practically unlimited.

"As mentioned above, the development of electric reducing has been most marked during the last few years in Sweden. At present some fourteen high furnaces are in operation, and the total output represents about 140,000 tons of pig-iron per annum. This pig is of the highest quality that can be made, and it commands, therefore, high prices. It is mostly used in Sweden for producing high-grade steel, but a certain amount is sold to the Sheffield market.

"There are, further, many more installations contemplated, and it is safe to say that wherever there is cheap water-power the old blast-furnace will be replaced by electric producers. Generally speaking, it holds good that wherever 1 horse-power per annum can be produced cheaper than the cost of 2 tons of charcoal or coke (depending upon the class of iron to be made) it is a commercially successful undertaking to substitute electric heat for fuel-heat.

"The system of furnace which is used throughout Sweden is that patented by Electro-Metals, Limited.

"It will be seen that the furnace consists of two principal parts—the furnace-shaft and the hearth or crucible. The shaft, which is of similar design to an ordinary blast-furnace shaft (but, of course, without any blast-tuyeres), is supported independently on an iron framework or on heavy girders resting on the walls of the furnace-house. It consists of a shell of steel plates and is lined with firebrick. It is provided with a closed furnace-top, the charging-bell of which is raised or lowered by means of an electric motor and winding-drum. The hearth, which is situated immediately below the shaft, is so constructed that when it is expanded by the heat the central hole in the arch which covers it fits closely around the neck of the shaft.

"The hearth also consists of a strong shell of steel plates lined with refractory material and is covered by an arch, the weight of which may be supported entirely on the circular lining of the hearth, or else partly in this manner and partly by iron straps riveted to the shell of the shaft.

"The electrodes are preferably of circular section and provided with screw-joints for joining up end to end. They pass through the arch of the crucible at a slight inclination from the vertical. Water-cooled stuffing-boxes with asbestos packing are provided to prevent leakage of gas around the electrodes. The electrodes project into the hearth through the free space between the roof and the charge, which on descending into the hearth falls at an angle from the lower end of the shaft. The electric current is supplied to the electrodes through bronze contacts. Only carbon electrodes have, so far, been used owing to the high costs of graphite electrodes.

"The Electro-Metals furnaces are generally provided with an arrangement for gas-circulation, the gas being drawn by means of a fan from a gas outlet at the upper end of the shaft, and forced through a number of nozzles into the free space between the roof of the crucible and the descending charge. The object of this gas-circulation is two-fold—viz., to prevent overheating of the roof of the crucible and to facilitate the reduction process in the shaft. As regards the latter object, it is evident that the gas which becomes highly heated in the crucible assists in conveying heat to the charge in the shaft, thus extending the reduction zone and rendering it more effective through the increased volume of gas passing through.

"In this manner the percentage of CO_2 in the furnace can be kept higher than if no gas-circulation were used, and it is evident that this indicates a reduction in the fuel-consumption.

"The furnaces are placed in the central bay. On one side all the electrical gear is placed—transformers, switches, regulators, etc.—and this part is isolated from the metallurgical part. The power is derived from a hydro-electric plant nine miles and a half away, which power-station belongs to the company. The voltage of the line is between 12,000 volts and is reduced to low pressure by transformer and adjusted by regulators to between 50 to 100 volts, as required.

"Each furnace has six electrodes, cylindrical in shape, and arranged to be used continuously without waste by using a screw-joint.

"The pouring-bay is fitted with electric overhead travellers, as well as trolly-tracks for transporting iron and slag. The iron can either be poured to pig or conveyed in ladles to the Bessemer and open-hearth furnaces. The slag is run into block moulds and makes excellent building-stone.

"The crushing-room is at the end of the furnace building. There are three crushers of the ordinary jaw type. There is a railway-track outside, and the daily requirements are supplied in the trucks, so that there is no need for large storing-bins. One of the crushers is fairly large, with wide enough jaw-space for the biggest lumps, and the ore passes from this crusher to the smaler ones, and thence by a bucket elevator to a belt-conveyor above the charging-platform, so that the raw material may be unloaded when required. There is a small ore-store, but this only contains some limited reserve amounts of the various kinds of ores used. The charcoal is transported from the stores by a ropeway.

"Three different kinds of pig-iron have been produced:—

(1)—Pig-iron for open-hearth treatment.

(2)—Pig-iron for Lancashire treatment.

(3)—Pig-iron for Bessemer treatment.

"The quality which is desired from the open-hearth pig is semi-spiegel and contains: Si, 0.40 to 0.60 per cent. Mn, 0.30 to $.05 per cent.; P, 0.011 to $.$18 per cent.; S, 0.015 per cent.

"It will be seen that it is more economical to produce spiegel iron in the electric furnace, and arrangements have been made to alter the open-hearth furnaces so as to use spiegel iron only.

"It has been assumed in various quarters that it would probably be difficult to maintain a constant product in an electric furnace. Experience has proved on the contrary, that a much more constant product is obtained from the electric furnace than from the old blast-furnace. One reason for this is that there is such a large receiver or collecting-basin in the lower part of the electric furnace that it acts as a regulator on the quality.

"The Lancashire pig required is quite white, and has the following analysis: Si, 0.20 to 0.30 per cent.; Mn, 0.20 to 0.30 per cent.; P, 0.011 to 0.018 per cent.; S, 0.015 to 0.020 per cent.

"During the early operation of the plant in question there has been a tendency for the sulphur to be unduly high, but this was remedied by making the slag more basic whenever the furnace was run for Lancashire pig.

"The analysis of Bessemer pig used was as follows: Si, 1.00 to 1.40 per cent.; Mn, 2.50 to 3.00 per cent.; P, 0.015 to 0.019 per cent. S, 0.005 per cent.

"Excellent Bessemer has repeatedly been made of this pig. The early attempts were not good, but it was soon found that Si and Mn had to be increased. It had been assumed that the amount would be normal, but apparently the lower temperature of the electro-Bessemer pig as compared with ordinary Bessemer pig from blast-furnaces necessitates a higher content.

"General experience points to the following results: It is cheaper to make spiegel than grey pig, because: (1) More current can be put through the furnace; (2) the current consumption is lower (per ton of product); (3) thus the production is higher; (4) the electrode consumption is lower; (5) the repair costs are lower.

"It may further be stated that rich charges give better (economic) results than poor ones. The quality

of the pig, however, is not influenced by the percentage of iron contents of the ore.

"For some time past the gas from the furnaces has been used as fuel in the open-hearth furnaces, and it is estimated that the value of the gas is from 2 to 3 shillings (50 to 75 cents) per ton of pig-iron produced.

"Finally, regarding the influence of the electric pig on the finished steel, experience has shown that the change tends to make better steel; this applies both to Bessemer and soft and hard open-hearth steels.

"The steel produced at Hagfors is of the highest quality, and is mainly used for locomotive-boiler, tubes, piano-wires, and high-tension wires generally.

"In Sweden, generally, the electric reduction of iron ore is regarded as revolutionizing this industry, and preparations are being made for constructing mills of considerable capacity. Recent experience has shown that large electrodes can be used at the same time as the current intensity on the electrodes is increased. Large furnaces will therefore be designed, and some of those now building have a capacity of 8,000 horse-power each.

"The general experience has been that the handling of the electric-reduction furnace is considerably simpler than an ordinary blast-furnace. More even quality is obtained without so careful watching. The quality can be changed easily, and the various grades from grey pig to spiegel can be obtained by simple manipulation. Less attention and less labour are required."

During the present investigation I have been in correspondence with Messrs. Electro-Metals, Limited, 56 Kingsway, London, W.C. 2, and reproduce the following extracts from two of their letters:—

Letter from J. O. Boving, June 28th, 1918.

"We have received your kind letter of the 5th inst., with regard to electric reduction of iron ore in Canada. It was exceedingly pleasant reading to the writer personally, who has for many years been in touch with various parties in Canada, and could never understand why the electric reduction had not made any progress in a country where the conditions are so singularly suitable for the development of this industry. . . .

"Since you were in Sweden very great developments have taken place, and this has, of course, been especially accentuated by the war, when importation of coke has been difficult, and therefore the power existing in the country has been of greater value than ordinarily for electro-thermical operations.

"You will probably remember most of the plants you visited in Sweden, but we shall here recapitulate what has been done as far as we are acquainted up to now.

"There are two furnaces at Trollhattan—the original one and another of 3,000 kw. capacity.

"There are five at Hagfors—the two original ones and three later of 4,000 kw. capacity.

"There are three at Domnarfvet (the Helfenstein furnace was found quite useless and has been pulled out)—one of 7,000, one of 3,000, and one of 2,000 kw. capacity—and there are two more building of 3,000 kw. capacity.

"There is one at Soderfors of 5,000 kw.; one at Ljusne of 3,000 kw.; two at Porjus of 3,000 kw.; and three at Lulea of 3,000 kw.

"Some have been built in Norway, two in Switzerland, and two or three in Japan.

"The most important plant we have tackled is, however, the one in the Aosta valley, Northwest corner of Alpine, Italy. Here we are erecting for the firm of Ansaldo & Co. (the largest armament firm of Italy) a reduction plant consisting of six units each of 3,000 kw. capacity. Two of these furnaces will be run on charcoal and four on coke. Half of the furnaces are built here and the half to our drawings in Italy.

"We are going to work out a revised estimate of the cost of this plant as applied to Canadian conditions and send along as soon as possible. This will give you a good idea of what you could look forward to. We shall also give you data regarding power consumption, electrodes, labour, charcoal, and other supplies.

"Whilst we write you about reduction furnaces, we think it is only right that we should inform you about the most remarkable developments which have been achieved with our steel-furnaces.

"The electric steel-furnace is undoubtedly the easiest apparatus existing to-day for melting steel and purifying it afterwards. The great flexibility of the electric heat and the possibility of applying it at the right point makes the removal of impurities, such as phosphorus and sulphur, and further complete deoxidation a very easy matter, and steel-makers in Europe are now unanimously of the opinion that as soon as the war is over electric furnaces will be installed by all large steel-mills, even for ordinary grades of steel. The process will be that whilst open-hearth furnaces and Bessemer converters will be maintained, these will only be used for taking the steel a certain part on the way towards perfection, and the final touch up will be made in the electric furnace. Treating molten steel in the electric furnace and refining it from impurities requires for a large unit between 80 and 100 kilowatt-hours per ton. This consumption is not prohibitive even under conditions such as are prevailing in this country, where power under ordinary conditions is available at a price of about one-third of a penny (0.7 cent). But it is a remarkable fact that even now during the war, when price for power ranges from 1 to 2 cents per unit, certain manufacturers, such as Brown-Bayley, Hadfield's, Cammell-Laird, and the Partington Steel Works, find it profitable to use our electric furnaces for treating ordinary carbon steel, starting from the cold. It should be, of course, remembered that this can only be done in fairly large furnaces having a capacity of at least 5 tons, because the current consumption increases very rapidly for small units. Thus, whereas a 1-ton furnace requires about 1,200 units for melting and refining 1 ton of scrap, a 5-ton furnace only requires about 750 units for the same work ,and a 10-ton furnace round about 600 units.

"When we come to consider electric furnaces receiving their power from hydro-electric installations, the question comes into quite a different plane. In many cases it is possible to supply the current at the rate of 0.1 cent, and the price of the total current consumption is thus so reduced that the whole process compares very favorably with the most economical coal-gas-fired open-hearth furnaces.

"In connection with Messrs. Ansaldo's Reduction Works a large steel-works is also being installed. The rich gases from the reduction-furnaces are used in the steel-works, but there will also be a battery of ten

15-ton electric steel-furnaces, all energized by water-power. You may be interested to know that Ansaldo's metallurgical engineer is Professor and Dr. Giolitti (of carburizing-of-steel fame), and their steel-works are regarded as obtaining higher quality results than any other works.

"On the coast of Norway there are also a number of electric steel-furnaces energized by water-power, and these undertakings are paying extremely well, turning out fine steel and making huge profits."

Letter From J. Bibby, September 21st, 1918.

"The production costs given in our letter of August 19th (see Appendix X.) are for the manufacture of white pig-iron as you surmise, and these are to be obtained in the large plant at Messrs. Ansaldo's about which we wrote you. For the manufacture of grey foundry pig-iron in this large plant the consumption will be approximately 0.37 horse-power year per ton of pig-iron, assuming that the ore contains between 65 to 70 per cent. of iron.

"For a plant consisting of only one 4,000 horse-power furnace, for instance, the consumption would be from 5 to 10 per cent. higher, as the diversity factor would be greater. For the case you mention of 9,000 tons per year you could assume a consumption of 0.41 horse-power year per ton of grey iron produced from ore containing 65 per cent. of iron.

"With reference to the sintering mentioned on page 4 of your letter, it is quite a common practice in Sweden to employ as much as 50 per cent, sintered and 50 per cent. lump ore and obtain satisfactory results.

"With reference to the price of current in British Columbia, we do not see why the cost there under similar circumstances should greatly exceed what is being done in Sweden, where current is being regularly supplied at the equivalent of $8 per horse-power year. The electric suppliers must take into account the favorable nature of an electric-furnace load as regards power factor and load factor. Under the circumstances you give of a 60-cycle supply running one furnace, the power factor would be as high as 0.92.

"With reference to charcoal, we are in a position to supply drawings and specifications for charcoal plants to suit any given requirements, and if desired we could quote you a fee for this work.

"We are pleased to learn that you are contemplating a new edition of your valuable book on electric furnaces, and we believe that you will consider a description of our recent developments worthy of notice. We are therefore preparing a description of the variour improvements we have made since your book was published, and will send this on to you in due course. These improvements consist in the employment of a new 2-phase system for small furnaces up to 7 tons, and a new 4-phase system for furnaces between 7 and 30 tons capacity. We have also made improvements in the way of automatic regulators, electrode economizers, etc., all of which we will give you particulars. In the meantime we enclose you two electrical diagrams which no doubt will be quite clear to you.

"As regards the 6-phase arrangement, this is applied to our 3,00-kw. reduction-furnace. As before, we employ three transformers which each supply two diametrically opposite electrodes, but we so connect the transformers that we obtain six independent phases in which the relationships are definitely fixed."

In conclusion, I may say that the Electro-Metals furnace is undoubtedly the most efficient appliance that has so far been applied to the electric smelting of iron ores, but that in view of the large consumption of power by even this type of furnace it will be unwise to put up an elaborate plant of this kind unless an adequate and permanent supply of electric power can be obtained at a moderate price.

Unfortunately, some of the earlier reports gave exaggerated ideas of the economy of electrical power and charcoal that had been obtained with these furnaces, and I myself made the mistake of taking these reports literally when writing the 1914 edition of my book on "The Electric Furnace." After visiting Sweden and investigating the conditions obtaining there, I arrived at more conservative figures as put forward in my 1915 report. In Mr. Bibby's letter of September 21st, quoted above, he states that with a single furnace of 4,000 horse-power producing 9,000 tons per annum, the consumption would be "0.41 horse-power year per ton of grey iron from an ore containing 65 per cent. of iron." It will be obvious that from the available ores, which do not contain more than 55 per cent. of iron, the figure I am assuming of 0.45 horse-power year will not be too high.

Although the Swedish furnace is more economical than any other electric ore-smelting furnace, there still remains a considerable margin for further possible improvement, and I hope that some process of low-temperature reduction of iron ores may be worked out which will show a decided improvement over the Swedish process.

II. The Helfenstein Furnace.

The Helfenstein furnace was originally devised for the production of calcium carbide and ferro-silicon. (See R. Taussig Faraday Society, V., 1910, page 254; Soc. Chem. Ind., XXXIX., 1910, page 435; Met. and Chem. Eng., X., 1912, page 686.) A 10,000-horse-power furnace of this type for iron-smelting was started at Domnarfvet in May, 1913, and was in experimental operation at the time of my visit in 1914. A more recent account apeared in Iron and Coal Trades Review (London), February 23rd, 1917, and in Met. and Chem. Eng., May 1st, 1917, page 509, from which I have taken the following particulars:—

When charcoal was used, the consumption of power, etc., was 2,170 kilowatt-hours, 380 kg. charcoal (70 per cent. carbon), and 5 kg. of electrodes per metric ton of pig-iron. When coke was used, the consumption was 2,600 to 2,700 kilowatt-hours, 310 to 320 kg. of coke, and 4 kg. of electrodes. The consumption of 2,170 kilowatt-hours, with charcoal corresponds to 0.392 horsepower year at 85 per cent. load factor. This is probably for the production of white iron from high-grade ores, though at the time of my visit ores of 50 per cent. iron were being smelted. It does not appear that the efficiency is any better than that of the Electro-Metals furnace, and it should be noticed that the use of coke causes the consumption of a far greater amount of electrical power.

The idea of this furnace is to increase the output and efficiency by using a far larger amount of power in a furnace of a given size than was possible in the Electro-Metals furnace. The furnace gases were not used to reduce the ore in the furnace, but were employed for other purposes in the plant. It is unfortunate that we have no detailed account of the operation of this furnace, or of the reasons which caused it to be abandoned.

III. The Noble Furnace.

At Heroult, in Californa, electric smelting of iron ores was undertaken in 1907, and was continued, experimentally, until about 1914. The first furnace was designed by Paul Heroult, and was a 2,000 horsepower rectangular furnace, with three vertical electrodes alternating with four vertical chutes for supplying the ore charge. The furnace had an arched roof and the chutes were heated by the escaping gases. The chutes became choked with the heated ore, the roof broke down of melted, the furnace could only be worked with an open top, and was finally given up. Professor D. A. Lyon experimented in 1908 with a single-phase furnace of 160 kw., and in 1909 put up a furnace of 1,500 kw., substantially like the earlier Swedish type of furnace. Work with this furnace was continued until 1911, when it was finally given up, possibly on account of difficulty in controlling the nature of the product. The Noble Company then reverted to the rectangular type of furnace, using four electrodes and five charging-chutes, which, however, were not heated. A 2,000-kw. furnace was built in 1911, and an additional furnace of 3,000 kw. in 1912 or 1913. The best account of this furnace was written by John Crawford, the plant manager, in Met. and Chem. Eng., July, 1913, Vol. XI., page 383.

Mr. Crawford states that the tall-shaft furnace built in 1909 could probably have been made economically efficient, but that it could not be made to respond readily to changes in the burden, as would be essential for making consistently high-grade foundry iron. He explains the necessity in electric smelting of controlling accurately the addition of carbon in the charge, as an excess of carbon cannot be burnt off as in the blast-furnace, and a deficiency results in low-grade iron. This difficulty of controlling the amount does not interfere with the production of a low-silicon iron — such as is used in Sweden — but in his experience it caused great difficulty in the production of foundry iron. In view of this the shaft-furnace was abandoned, and a 2,000-kw. 3-phase furnace of the long and narrow type was tried. This furnace had four electrodes, delta-connected and suspended between five charging stacks. He considers this type of furnace, which was operating in 1913, is the one best adapted to their needs. The second furnace of this kind, having 3,000 kw. capacity, consists of a rectangular steel shell 28 feet long and 10 feet wide, lined with standard firebrick. This is surmounted by five charging-stacks 18 feet high, and between the stacks the top of the furnace is arched over. The electrodes are of Acheson graphite, 12 inches in diameter, and enter vertically through the arch between each adjacent pair of charging-stacks. The furnace gases are not used for preheating or reducing the ore, but are led away and used under lime-kilns and charcoal-retorts. The electric current is supplied to the furnace at a voltage of from 40 to 80. He found that coke was less satisfactory than charcoal in this furnace, but that if the coke was crushed a mixture of 60 per cent. coke and 40 per cent. charcoal could be used with fair efficiency. The following is an analysis of a 200-ton lot shipped to a foundry for making steel castings:—

	Per Cent.
Silicon	2.88
Combined carbon	0.09
Graphite carbon	3.38
Sulphur	0.028
Phosphorus	0.031

Mr. Crawford does not consider this type of furnace as efficient as the shaft type, but states that he has kept the power consumption as low as 2,200 kilowatt hours per ton of pig in a furnace of 300 kw. This would equal 0.40 horse-power year at 85 per cent. load factor. He states, however, that the long and narrow type offers the possibility of building several furnace units on to each other, like copper blast-furnaces, and this would lessen the radiation and electrical losses and increase the efficiency. It would also enable part of the furnace to be repaired while the remainder was still in operation.

Since Mr. Crawford's article scarcely anything has been published about the Noble smelting-furnace, but I learn that the production of pig-iron was discontinued about 1914. This may not have been caused by any technical difficulty, because the commercial situation at Heroult, which can never have been very good, became impossible when the charge for power was raised from $12 to $25 per horse-power year. The plant is situated on the Pitt river, in Shasta County, and is reached by an independent line of rails from Pitt Station, on the Southern Pacific Railroad. The iron ore is about the only element of their supply which can be obtained cheaply at the works; there is not enough timber left near the plant for charcoal-making, and wood for this purpose has to be brought in by rail. All their general supplies and their products have to be shipped over two railroads from or to San Francisco or other industrial centre.

IV. The Open-Pit Furnace.

For the production of calcium carbide and ferro alloys a simple type of open-topped furnace has been developed, and this is recommended by Messrs. Beckman and Linden for the smelting of iron ores. The 3,000-kw. furnace erected by this firm at Bay Point for the production of ferro-manganese may be taken as typical. It consists of a rectangular steel box, about 17 feet long, 9 feet wide and 7 feet high, suitably braced outside, and lined around the sides with 4½ inches of firebrick. The bottom lining is about 3 feet thick, composed of blocks of carbon, and the furnace is supported on piers to permit of air-cooling. The top of the furnace is open, and the three electrodes, which are of amorphous carbon, hexagonal in section, 24 inches in diameter and 7 feet long, are hung in the middle line of the furnace, being spaced 3 feet 6 inches apart from centre to centre. The lower ends of the electrodes are surrounded and covered by the ore and other materials when the furnace is operating. The upper ends of the electrodes are held by water-cooled metal-holders, which support the electrodes at the correct height and supply the electric current to them. The heights of the electrodes is controlled and regulated by automatic machinery, which is designed to keep a constant electrical load on the furnace. Three-phase electrical power at 22,000 volts is supplied to three 1,000-kw. transformers, from which the working-current, at 70 to 100 volts, is led by flexible conductors to the electrode holders. A charging-platform extends around the furnace about 3 feet below the top, and the mixture of ore, carbon, and flux is shovelled into the furnace from this platform. The molten ferro-manganese and slag are allowed to run out of the furnace periodically by means of a spout and tapping-hole opposite the centre electrode.

There can be no question that charcoal pig-iron of any desired grade can be made in this kind of furnace, which is easily and cheaply built and repaired, and should be able to run for a long time without need of repair. By providing an ample supply of powert he efficiency should be satisfactory, and may be expected to approach fairly closely to that of the Swedish furnace. The charcoal-consumption will certainly be higher, but, as a poorer quality charcoal can be used, this need not cause any additional expense. The power-consumption will probably be higher; but it is impossible to speak positively on this point, because the loss in heat, due to the open top and the absence of a stack, may be largely balanced by the greater efficiency of a higher-powered furnace, and by the fact that stoppages for repairs will be fewer and less prolonged. The consumption of electrodes will probably be larger per ton of pig-iron, because they are somewhat exposed to the air, and perhaps also on account of the greater current density used in these electrodes. Although, in general, the furnace has much to recommend it as a simple and effective means for making iron, it must be remembered that the furnace gases are allowed to burn above the charge; thus not only are they wasted, but they create a serious nuisance. It is difficult to avoid the conclusion that, in operating such a furnace for the commercial production of pig-iron, the management would ultimately be obliged to close in the furnace-top, so as to remove the gases from the furnace-room, even if the value of the gases were neglected. The furnace, so closed in, would then resemble the Helfenstein or the Noble furnace, already described. If, then, it is decided to smelt in an electric furnace other than the Swedish type, it would be practicable to start with a simple pit furnace as used for ferro-manganese, and to add to this, if it seems desirable, provision for retaining the heat and gases and supplying the charge in a more mechanical manner.

If it is found practicable to reduce the crushed ore to a metallic powder in some gas-fired furnace, this powder can be melted down very simply and cheaply with additions of carbon and ferro-silicon to produce foundry pig-iron. A simple electric furnace provided with a cover will probably be the best for this purpose.

APPENDIX IX.

Design and Cost of Plant for the Electrical Smelting of Iron Ores.

General Considerations.

(1.) We have seen that in view of the limited market it is undesirable to present to consider the production of more than 20 or 30 tons of pig-iron daily for use in foundries.

(2.) The cost of production on so small a scale would be very high, and, as there will not be a great profit in making pig-iron, it seems doubtful whether a plant of that size could pay its way under ordinary conditions.

(3.) If, however, we include in the plant furnaces for the production of steel and ferro-alloys, which can probably be made with a greater profit, and apart from this will help to carry the general overhead charges, there is more probability that the plant can be made to operate at a profit.

Electro-Metals Plant.

Messrs. Electro-Metals, of London, are installing an iron-smelting plant for Messrs. Ansaldo & Co. in the Aosta valley in Italy, and I have received from them the following estimate of the cost of building a similar plant in Canada.

The plant would consist of six electric furnaces of the Swedish type, each using 3,000 kw. and producing 10,000 tons of pig-iron a year. This is for the production of a low silicon or white pig-iron from an ore of about 65 per cent. iron. The plant would consist of a large furnace building, divided lengthwise into three bays. One of these contains the transformers and other electrical apparatus, the central bay would contain the six electric furnaces, and the remaining bay would be devoted to the disposal of the pig-iron and the slag. Besides these, there would be a storage-house for the charcoal, and stores for electrodes and other supplies, with bins or storage-space for the ores, fluxes, and pig-iron. No mention is made of unloading piers or wharves, or of railroad-tracks, or of the land on which the works would be erected, and it seems probable that further charges should be made for these.

The plant of 18,000 kw. is estimated to cost:—

Six shafts complete with charging-bells and pipes	$170,000
Twenty (1,000 kw.) transformers (two spares)	150,000
Switch-gear	40,000
Elevators	15,000
Pumps and water plant	40,000
Blowers, fans and ducts	20,000
Motors	5,000
Buildings	100,000
Total	$540,000

This is equal to $9 per ton of yearly output.

For present consideration we may take a plant, producing pig-iron alone, of half this size; that is, of 9,000 kw. This would make more pig-iron than we need, but would be of about the right effective size and expense. Such a plant, with additional charges for the land, unloading wharf, tracks, and rolling-stock, would cost in the order of $350,000 to $400,000. The estimated output for this would be 30,000 tons per annum, but this should be corrected (1) for the ore being of 53 per cent. iron instead of 65 per cent., which will probably reduce the output from 30,000 tons to 26,000; (2) a further correction, in view of the production of foundry instead of white iron, will reduce it to 24,400 tons, or 8,100 tons for each of the three furnaces.

It is probable, however, that the estimated output of 60,000 tons from a six-furnace plant was a conservative figure, and it appears reasonable to assume an average daily output per furnace of 25 tons of foundry iron, even from the low-grade ores of British Columbia. Twenty-five tons a day per furnace would be 9,000 tons per annum for each furnace, or 27,000 tons for the whole plant, and I shall base my calculations on this.

By way of comparison, I add an estimate, made for me in 1914, of the cost of building in Canada a 9,000-kw. plant of the Swedish type. The estimate was pre-

pared by Mr. Assar Gronwall, of Ludvika, in Sweden. It is probable that the firm have introduced some economics since the date of this estimate, but the cost of construction, especially in British Columbia, has increased rapidly, and it seems likely that a complete plant, including land, wharf, and rolling-stock, will cost in the order of $400,000, or $15 per yearly ton of output.

Plant of Three Electric Furnaces of 3,000 Kw. each.

Excavation, levelling, railway-tracks, storehouse for ore and coke or charcoal, foundations for buildings and furnaces ..	$ 30,000
Buildings—	
House of light iron construction for three furnaces	60,000
Crusher-plant house, laboratory, inclusive of appliances, workshop for repairs, and storehouse, and various smaller shops	12,000
Furnaces—	
Three furnaces at 4,000 horse-power, with fans and gas-pipes	75,000
Electric transformer instruments with low-tension conductors	100,000
Moulds, ladles, tools and instruments	10,000
Travelling crane of 5 tons capacity ..	6,000
Ore-crusher, apparatus for transporting crushed ore to the furnace-top	7,000
Side-tracks for transport and other transporting devices	7,000
Water-pipes and waste-pipes	5,000
Drawings, supervision during construction, and unforeseen expenditures .	48,000
Total	$360,000

If the Electro-Metals type of furnace is used there would probably be only two of these built, and the remaining power would be devoted to the production of ferro-alloys and to steel-making.

Plant with Open-pit Furnaces.

I visited in California a plant at Bay Point, San Francisco, and another at Heroult, in Shasta County, where ferro-manganese and other ferro-alloys are made in electric furnaces. The largest furnace used was a rectangular open-pit furnace, using 3,000 kw. and having three 24-inch carbon electrodes which are suspended in the furnace. Messrs. Beckman and Linden, who built and operated the plant at Bay Point, consider that furnaces of this type would give entire satisfaction for the production of pig-iron, and that such furnaces would have the added advantage that they could be employed at any time for the production of ferro-alloys. These furnaces would undoubtedly be cheaper to build and the repairs would be less costly, but, on the other hand, they would also certainly be less efficient than the Swedish furnaces. Messrs. Beckman and Linden prepared for me an estimate of the cost of a plant of this type, having one 3,000-kw. furnace for the production of pig-iron and other smaller furnaces for ferro-alloys. I have changed a few of their figures to provide for the construction of two 3,000-kw. furnaces.

7,000-kw. Plant for Pig-iron and Ferro-alloys.

Two 3,000-kw. 3-phase furnaces, installed, including casing, electrode-holders, jib-cranes, regulators, and foundations ..	$ 30,000
Seven 1,000-kw. single-phase, 33,000-volt, primary, 60-cycle oil-insulated and water-cooled transformers, installed, with from 60 to 120 volts in 5-volt steps on the secondary side (one of these transformers is spare), at $6,500	45,500
Two sets low-tension busses for 3,000-kw. furnaces, installed	10,000
Two sets high-tension busses for 3,000-kw. furnaces, including oil-switches, switch-board and meters	12,000
Three 300-kw. furnaces, single-phase, installed, including casing, electrode-holders, and regulating device	10,000
Four 300-kw. 33,000-volt primary, 60-cycle, single-phase, oil-insulated and water-cooled transformers, installed, with a range of from 70 to 100 volts in 5-volt steps on the secondary side	10,000
Three 50-kw. single-phase, 60-cycle, 33,000 volts to 440 volts, air-cooled transformers, installed, with switchboard (to be used for industrial purposes around plant)	2,000
One 25-kw. motor-generator set for regulators, etc., installed	2,000
Three sets low-tension busses for 300-kw. furnaces	1,500
One furnace building, built entirely of reinforced concrete, including electric travelling crane, tracks, metal-handling equipment, etc.	45,000
One transformer building, built entirely of reinforced concrete	13,000
One shipping-store building of wood and stucco exterior finish	7,000
One laboratory with complete equipment ..	7,500
One store-room and change-room building, built of wood and exterior stucco finish, including steel lockers, toilets, wash-basins, and shower-baths	8,000
One machine-shop with equipment	10,000
One office building	3,000
One gate-house with time-clock and time-keeper's office	500
Railroad-tracks, industrial track, ore-handling equipment, water-supply, sewerage, fence, and industrial lighting, etc.	25,000
Land, 4 acres	4,000
	$246,000
Engineering and contingencies, 20 per cent.	49,200
Total of Beckman and Linden's estimate	$295,200
Additional items—	
Dock with unloading locomotive, crane, etc.	30,000
Charcoal storage	8,000
3- to 10-ton ladles for handling metal	6,000
Flues and stack	25,000
Total	$364,200

Say a total of $350,000.

In the above list I have added to Messrs. Beckman and Linden's estimate a few items that should apparently be included. A dock and unloading plant would be needed for economical operation on a large scale, a storehouse would be needed for the charcoal, and it will probably be desirable to use large ladles for handling the molten metal. In the plant at Bay Point the furnace gases escape and burn in the furnace-room, creating a very serious nuisance. I would advise the construction of suitable flues and stack for the removal of furnace gases and the collection of the dust blown out by the furnaces. These flues can be placed below the charging-platform.

The above estimate represents the cost of a complet plant having one furnace making foundry iron for sale, a second making white iron for steel-making, and three smaller furnaces for ferro-alloys. As, however, we are considering in the first place the cost of production of pig-iron alone, I have rearranged the estimate for this purpose, so as to represent a plant of 9,000 kw. making foundry iron in three 3,000-kw. furnaces. This estimate should then be comparable with the Swedish estimates for a 9,000-kw. plant.

Beckmna and Linden's Estimate Modified for a 9,000-kw. Plant Making Pig-iron.

(For details see previous estimate.)

Three 3,000-kw. furnaces	$ 45,000
Eleven 1,000-kw. transformers (two spares)	71,000
Three sets low-tension busses	15,000
Three sets high-tension busses	18,000
Three 100-kw. transformers, etc.	3,000
One 25-kw. motor-generator, etc.	2,000
One furnace building, etc.	35,000
One transformer building	15,000
One shipping-store	7,000
One laboratory	7,500
One store-room	8,000
One machine-shop	10,000
One office building	3,000
One gate-house	500
Railroad-tracks, etc.	25,000
Land	5,000
	$270,000
Engineering, etc., 20 per cent	54,000
Total from Beckman and Linden's figures	$324,000
Additional items—	
Dock, etc.	30,000
Charcoal storage	8,000
3- to 10-ton ladles	6,000
Flues and stack	25,000
Total	$393,000

The corresponding figures, derived from the Swedish estimate, were between $350,000 and $400,000, but this does not mean that the Swedish furnace is the cheaper, as the estimates differ in completeness and are based on different conditions. We may, however, conclude that a complete plant using 9,000-kw. for the production of pig-iron would cost about $400,000. It would appear certain that with an equal completeness of construction the Swedish plant would be somewhat more costly than the other, and for further calculation we may assume the cost of a Californian plant of 9,000 kw. to be $400,000, and of an equally complete Swedish plant $450,000.

In order to obtain an independent judgment in regard to the general arrangement and cost of an electric-smelting plant in British Columbia, I discussed the design with Mr. R. H. Stewart, of Vancouver, and he contributed some general considerations in regard to the design and cost data for the general portions of the plant, exclusive of the electrical furnaces and appliances.

The design was for a plant of 20,000 horse-power (15,000 kw.) for the production of 100 tons of iron daily and 20 tons of ferro-alloys. The plant was designed to handle daily the following quantities:—

	Tons.
Iron ore	200
Charcoal	50
Limestone	20
Electrodes	2
Manganese ore	20
Quartz	10
Chrome ore	10
Scrap-steel	20

Although the plant as a whole was based on a daily capacity of 100 tons of iron and 20 tons of ferro-alloys, the electrical and furnace equipment is only about half of this, corresponding to a consumption of 10,000 horse-power or 7,500 kw., and a production of 50 tons of pig-iron and 5 tons of ferro-alloys; provision being made for extension at a later date.

The furnace building would be 50 feet wide, 30 feet high, and 150 feet long. It would contain along one long side two 3,000-kw. open furnaces for smelting iron ore and three 300-kw. open furnaces for ferro-alloys. On the other side of this wall would be the transformer building, 30 feet wide and 30 feet high. The supplies of ore for the furnaces would be delivered by an elevated track in front of the furnaces and level with the charging-platforms. The furnace gases would be removed by flues below the charging-platforms. The pig-iron could be tapped into large ladles and cast in sand or in a casting-machine or poured direct into a Bessemer converter for steelmaking. The ores and other supplies coming by water would be unloaded into storage by a locomotive crane. The charcoal would need a large storage-shed, perhaps 300 feet long and 90 feet wide, which would contain a month's supply, stored not more than 10 feet deep.

The order of operations would be as follows:

(1)—Unloading from the dock directly into storage.

(2)—Removing from storage, using the same crane, to crushing and sampling plant.

(3)—Removal from crushing plant to the furnace charge-bins.

(4)—Delivering from charge-bins over weighing-hoppers to the charge-cars and thence to the side of the furnace.

(5)—Smelting for pig iron or ferro alloy.

(6) Molten pig-iron received in ladle and handled by crane to castin-bed or casting-machine or to steel-making furnace.

(7)—The slag would be received in a ladle and removed by a locomotive.

The following is based on Mr. Stewart's estimate for the cost of buildings and general plant. Items for the furnaces and electrical equipment have been added from Messrs. Beckman and Lindens' estimate:

20,000-h.p. Plant with 7,000-kw. of Electric Furnaces and Equipment.

Mr. Stewart's items—	
Locomotive crane, buckets, and grab-buckets	$ 19,000
Dock, say	10,000
Electric locomotive, cars, and equipment for handling between the wharf and the crushing plant	10,000
Crushing and sampling, say	17,000
Charcoal storage for one month's supply	8,000
Tracks, etc., for the above-mentioned equipment	3,500
Lifting-magnet for steel scrap, etc.	1,200
Storage of manganese ore	3,500
Storehouse for electrodes and other supplies, including a small crane	6,000
Six furnace charging-bins, including weighing-hoppers and mechanical feeders	9,000
Tracks, charge-cars, and locomotive, with supports for the overhead track	10,000
Furnace building, including crane runway	25,000
Transformer building	12,000
3- to 10-ton ladles	6,000
Flues and stacks	25,000
20-ton crane, 50-foot span	18,000
Laboratory and equipment	6,000
Office	5,000
Machine-shop and blacksmith's shop	12,000
Wash-house and change-room	3,000
Slag-handling equipment	8,000
Items from Messrs. Beckman and Linden—	
Two 3,000-kw. 3-phase furnaces, installed	30,000
Seven 1,000-kw. single-phase transformers	45,500
Two sets low-tension busses for 3,000-kw. furnaces	10,000
Two sets high-tension busses, etc., for 3,000-kw. furnaces	12,000
Three 300-kw. single-phase furnaces, installed	10,000
Four 300-kw. transformers, installed	10,000
Three 50-kw. single-phase transformers	2,000
One 25-kw. motor-generator set for regulators	2,000
Three sets low-tension busses for 300-kw. furnaces	1,500
Land, say	6,000
Engineering and contingencies, 20 per cent. on $129,000	25,800
Total	$372,000

Modifying this estimate to represent a plant of 9,000-kw. making pig-iron only, we have:—

9,000-kw. Plant for Pig-iron.

Mr. Stewart's items	$217,000
Three 3,000-kw. furnaces	45,000
Eleven 1,000-kw. transformers	71,000
Three sets low-tension busses	15,000
Three sets high-tension busses, etc	18,000
Three 100-kw. transformers	3,000
One 25-kw. motor-generators	2,000
Land	6,000
Engineering, etc., 20 per cent. on $160,000	32,000
Total	$409,000

These figures agree with the previous estimate of $400,000.

Design and Cost of Complete Plant.

The foregoing estimates of the cost of a 9,000-kw. plant for making pig-iron are for use in calculating the cost of smelting pig-iron. Any plant actually constructed would be more complex in nature, as it would include furnaces for ferro-alloys and for steel-making.

Such a plant, as has already been indicated, might suitably contain:—

Two 3,000-kw. furnaces making pig-iron.

Three 300-kw. furnaces making ferro-alloys.

This plant will produce daily about 25 tons of foundry pig-iron and about 30 tons of white pig-iron for steel-making, together with about 3 tons of ferro-alloys. The plant would cost in the order of $370,-000.

To make the plant complete and self-contained, there should be added electric or other furnaces for making steel, and a steel-foundry and rolling-mill for handling the steel so produced.

I have obtained from Mr. W. G. Dauncey approximate figures for the cost of a steel-foundry and rolling-mill. This plant would handle in all about 50 tons of steel per day.

Cost of Steel Plant.

Main foundry building, including drying-ovens, core-ovens, pits, moulds, and a 25-ton overhead crane and runway	$ 60,000
Lean-to building for furnace-house	12,700
Three 6-ton (rated) electric furnaces	75,000
Transformers and electrical equipment for three furnaces	54,000
One 9-inch rolling-mill, including building, one continuous heating-furnace, and three reheating-furnaces	125,000
Total	$326,700

Only two of the electric furnaces would be in operation at any one time, and they would use between them about 3,000 kw., which would bring the total consumption in the whole plant up to about 10,000 kw.

As an alternative to the above, Mr. Dauncey recommends a steel-foundry equipped with two oil-burning open-hearth furnaces, specified as follows:—

Two 15-ton open-hearth oil-fired furnaces; three 15-ton ladles; one overhead 25-ton travelling crane; twenty charging-trucks and boxes; storage oil-tanks and all necessary small equipment for handling 90 tons of steel per 24 hours	$145,000
Necessary buildings for the above	35,000
Total	$180,000

This second estimate is for steel-foundry only, without any rolling-mill, but, on the other hand, it has a capacity of 90 tons of steel in place of some 50 tons provided for in the first estimate.

Collecting the figures together, we find for the complete plant:—

7,000-kw. electric-smelting plant for making pig-iron and ferro-alloys	$375,000
3,000-kw. electric steel-foundry and rolling-mills	325,000
Complete iron and steel plant	$700,000

The final daily product of this plant, after allowing for the use of pig-iron and ferro-alloys in the plant itself, would be about:—

	Tons.
Foundry pig-iron	25
Ferro-silicon, ferro-manganese, and ferro-chrome	2
Steel castings and rolled steel	50

APPENDIX X.

The Cost of Making Pig-Iron.

Although the output of foundry iron for sale will be only 25 tons a day, a further 25 or 30 tons of pig-iron will be made for conversion into steel, and additional power will be used for steel-making and the production of ferro-alloys. Instead, therefore, of calculating the cost of producing iron in a plant of 25 tons daily output, using some 3,000-kw., we may fairly figure on a plant of three times this capacity, or 9,000 kw., with a production of 75 tons of foundry iron daily.

The main items of cost in the production of foundry iron are:—

Iron ore of about 55 per cent. costing $4 per net ton.

Charcoal costing $6 to $8 per net ton.

Electric power, labor, and management.

It was understood that electric power could probably be obtained for about $15 per horsepower year, and the following calculations were made on that assumption. It now appears that a charge of 0.5 cent per kilowatt-hour would be made for electric power, and a calculation on this basis is given towards the end of this Appendix.

The cost of labor is discussed in Appendix VII. and in the following pages: it appears to vary from about $4 to $8 per ton of pig-iron, according to the size and nature of the plant, and with the probable variations in wages.

The following discussion is based on the production of foundry pig-iron by the usual electric-smelting methods in furnaces of the Swedish or the open-pit type in a plant having a total production of 70 or 80 tons daily. The cost of making electric-furnace iron by a method involving the preliminary reduction or metallizing of the crushed ore is discussed in Appendix XII.

Cost With the Swedish Furnaces.

I have received from Messrs. Electro-Metals, of Sweden, the following estimate of the cost of a ton of pig-iron made in a six-furnace plant of $60,000 tons per year. I quote this unaltered, for interest, as showing the cost at which electric-furnace iron can be made under exceptionally favorable conditions:—

1.5 tons of ore at $1	$ 1 50
0.5 ton of lime at $1	50
0.33 ton of charcoal at $6	2 00
10 lb. of electrodes at 5 cents	50
Electric current at $8 per horse-power year	2 50
Repairs and maintenance	50
Labor	2 00
Management	1 00
Interest and depreciation	1 00
Total cost per ton of pig	$11 50

In this estimate the word "ton" probably denotes in each case the metric ton of 2,204 lb., which is nearly the same as the gross ton of 2,240 lb.

The corresponding figures in British Columbia, in view of the higher costs of ore, power, supplies, and labor, the smaller scale of the plant, the lower grade of the ore, and the production of foundry iron instead of white iron, would be about as follows for 1 gross ton of iron in a plant of three 3,000-kw. furnaces making 27,000 tons of iron per annum:—

2 net tons of ore at $4	$ 8.00
0.4 net ton of charcoal at $8	3.20
15 lb. of electrodes at 8 cents	1.20
0.45 horse-power year at $15	6.75
Repairs and maintenance	1.00
Labor	4.50
Management	2.00
Interest 6 per cent. and depreciation 10 per cent.	2.60
Royalty to Electro-Metals	50
Total	$29.75

It appears that by this system foundry iron can be made at a cost of about $30 per ton.

In regard to these figures it will be noted:—

(1.) That the charge for ore ($8) is high, partly because of the high cost per ton of the ore; this cost could probably be reduced to about $3 per ton of ore if the iron-mining industry should in the future develop on a larger scale. The charge is high, also, because the ore is low grade, containing about 55 per cent. of iron, so that 2 tons of ore are needed to yield 1 ton of pig-iron. If it were possible to obtain a 65-per-cent. ore at $3 per ton, the item of $8 for ore would be reduced to $5.

(2.) I have assumed elsewhere that charcoal could be made from mill-waste at from $6 to $8 per ton. For the open furnace I take the lower figure of $6, but for the Swedish furnace, which requires a better grade of charcoal, I am taking the higher figure. I see no prospect of a material reduction in this item. The amount charged (0.4 ton) is higher than in the

[illegible] table, partly on account of the production of foundry iron instead of white iron and partly because charcoal is weighed by the short ton and pig-iron by the long ton, while the original estimates are doubtless based in each case on the metric ton.

(3.) The electrode-consumption has been increased in view of the production of foundry iron, and the price is that at which electrodes can be imported from Eastern makers. It is possible that by making electrodes locally the cost could be reduced to 4 cents a pound, thus reducing the item from $1.20 to 60 cents per ton of pig-iron.

(4.) The charge of $2.50 for power, estimated by the Electro-Metals Company, corresponds with a consumption of 0.31 horse-power per ton of iron. This figure must be raised by about 0.05 on account of the lower grade of ore, and a further 0.05 on account of the production of foundry iron, thus making 0.41; 0.45 appears to be as low a figure as it is safe to assume under these conditions.* If in the future power could be obtained at $10 per horse-power year, the item of $6.75 would be reduced to $4.50, effecting a saving of $2.25 per ton.

(5.) The items for labor, management, and maintenance have all been increased from the Electro-Metals estimate in view of the high cost of labor and salaries at the present time. It does not seem likely that any material reduction in these items can be expected during the next five or ten years.

(6.) Interest at 6 per cent. was calculated on the cost of the plant, $400,000, and a working capital of $100,000; and depreciation was calculated at 10 per cent. on the cost of the plant. The output was taken at 27,000 tons per annum. Royalty to the Electro-Metals has been assumed at 50 cents per ton, but I have no grounds for this figure.

(7.) If the economies indicated in (1), (3), and (4) could all be carried out, the cost of making pig-iron would be reduced to about $24 per ton. In view of this, it would appear that a plant making pig-iron in the Swedish furnace with $10 power should be able to continue to operate at a profit even when prices fall considerably below their present level.

The following details of the cost of making electric-furnace iron (probably white pig-iron) at Gellivare, in North Sweden, are contained in a report by J. A. Leffler, which appeared in the Iron Age, September 13th, 1917, page 605. I have changed the items from English to Canadian money.

Cost of One (Metric) Ton of (White) Pig-iron.

1.6 (metric) ton of ore (50 per cent. ore and 50 per cent. briquettes) at $2.74	$ 4 38
Limestone	16
0.4 ton of charcoal at $12.50	5 00
0.272 kilowatt-year (0.365 horse-power year at $9.50)	3 46
Electrodes	44
Repair and upkeep	88
Wages	1 56
Management and sundries	54
Royalty	34
Sinking fund	86
Rents	1 38
Carriage to Lulea	1 16
Total	20 16

Comparing my estimate for present conditions in British Columbia, it will be seen:—

(1.) That we have to face an increase of $3.62 on the cost of ore.

(2.) The consumption of charcoal is taken as the same amount, but we should obtain charcoal more cheaply, thus saving $1.80

(3.) My power assumption is 0.085 horse-power year more than the above. This is justified by the lower grade of ore used and the higher grade of iron to be made. This difference, together with the increased cost per year ($15 instead of $9.50), produces an increase of $3.29 in the charge for power.

(4.) Electrodes cost 76 cents more on account of the greater consumption and the higher price.

(5.) Repairs and maintenance are only 12 cents more.

(6.) Royalty is assumed at 16 cents more.

(7.) Interest and depreciation in my estimate come to 36 cents more than the charges for sinking fund and "rents" in the Swedish estimate.

(8.) Labor and management come to $6.50 in my estimate, but only $2.10 in Sweden. This difference of $4.40 is due partly to the smaller scale of the proposed plant, but mainly to the very much higher scale of wages and salaries now obtaining in British Columbia.

It will be seen that the increased amount of my estimate (about $10 more than the Swedish cost) is due, in about equal proportions, to the increased charges for ore, power, and labor.

Magnetic Concentration of the Ore.

It may be worth while to attempt an estimate of the results of concentrating the ore before smelting it, so as to find whether any economy may be expected to result from this operation.

Assume the ore is a megnetite containing 50 per cent. of iron and costing $3 a ton at the concentrating plant, with a further charge of $1 per ton freight to the smelter. The cost, using the undressed ore, is $8.80 per ton of pig-iron, as 2.2 net tons of ore would be needed. The ore is crushed to a coarse powder at a cost of 50 cents a ton. One ton of the crushed ore will probably yield 0.6 ton of 70-per-cent. concentrate and 0.4 ton of 20-per-cent. tailings. The concentrate is sintered with cheap fuel on the Dwight-Lloyd machine and the briquettes shipped to the smelter. The cost of dressing and sintering will be about $1 per ton of the concentrate. The cost of the product per ton of pig-iron will be:—

2.4 tons of ore mined at $3	$ 7.20
2.4 tons of ore crushed at 50 cents	1.20
1.4 tons of concentrates, dressing and sintering at $1	1.40
1.4 tons of concentrates, freight at $1	1.40
	$11.20
2.2 tons of 50-per-cent. ore at $4	8.80
Increased cost due to process	$ 2.40

*A discussion of the power-consumption will be found in Appendix VIII.

On the other side we may expect the following economies:—

$2\frac{1}{2}$ lb. of electrodes at 8 cents	$ .20
0.08 horse-power year at $15	1.20
Repairs and maintenance	.15
Labor	.65
Management	.30
Interest and depreciation	.40
Total	$2.90

It does not appear, therefore, that a great saving could be effected by dressing a 50-per-cent .ore if crushing and sintering were necessary, though Messrs. Beckman and Linden consider that a net saving of nearly $3 per ton could be effected in this way. I may add that for this calculation I have assumed that the operation of sintering would remove the sulphur so completely that it would not be necessary to form a slag for its removal, and also that a white iron would be made and turned to foundry iron by the addition of ferro-silicon, so that it would not be essential to have any silica in the furnace charge. An alternative plan would be to use about two-thirds of sintered concentrates and one-third of undressed ore in the furnace charge, thus obtaining enough silica for the production of foundry iron.

Although the above calculation shows only a small saving by the concentration of a 50-per-cent. iron ore, it is possible that a more important economy could be effected by magnetic concentration in the manner indicate in Appendix III.

Production of Foundry Iron.

On account of the fact that the Swedish furnace is generally used for the production of white pig-iron containing not more than about 1 per cent. of silicon, we have no exact data for the production of foundry iron of, say, 3 per cent. of silicon in this furnace. We are satisfied, however, that there would be a decided increase on this account in the cost for power, charcoal, electrodes, and maintenance, besides the general overhead, labor, and interest charges. In view of this, it is worth while to consider what the cost would be of converting white iron into foundry iron by the addition of ferro-silicon. One ton of iron containing 1 per cent. of silicon would need the addition of 0.04 ton of 50-per-cent. ferro-silicon to raise its silicon content to 3 per cent. This ferro-silicon would cost, made in the plant, about $85 per ton, or $3.50 for the amount needed.

If the pig-iron were received in a large ladle and the ferro were thrown in red-hot, there should be enough heat to effect a perfect mixture; and as the iron is cast into pigs for sale, and then remelted in a cupola, any irregularity would be remedied before the final casting. The saving in the cost of smelting through producing white iron instead of foundry iron would about equal the cost of the ferro-silicon, and there would be the added advantage of making a single furnace product and turning as much of this as was needed into foundry iron.

Mr. Gronwall, in his estimate made in 1914, places the difference in cost between grey and white pig-iron as:—

0.03 ton of charcoal.
0.03 horse-power year.
5 lb. of electrodes.
10 cents for repairs.
7 cents for petty charges.

Under our conditions this would mean:—

Charcoal at $8	$0.24
Power at $15	.45
Electrodes at 8 cents	.40
Repairs and petty charges	.21
Total	$1.30

We must add, however, a proportion of the charges for labor, management, and fixed charges amounting to about 60 cents, thus bringing the whole up to $1.90. The additional expense may easily be as much as 0.05 ton of charcoal and 0.05 horse-power year, and the increased cost would then be about $3 a ton (everything considered), or nearly as much as the cost of the ferro-silicon addition.

The ferro-silicon used was found to cost $3.50, but, as it replaces an equal weight of pig-iron costing $1, the net cost of the addition will only be $2.50 per ton of the resulting foundry iron.

The foregoing discussion is not intended to prove that the addition of ferro-silicon to white iron is the best way of making foundry iron, but merely that the use of the Swedish furnace for foundry iron would be perfectly safe, because ferro-silicon could be added without much additional expense if it were found impracticable to make foundry iron directly.

Cost of Smelting in Simple Pit Furnace.

The following is an estimate of the cost of making a ton of foundry iron in a 3,000-kw. furnace of the simple pit type. This estimate has been prepared by Messrs. Beckman and Linden, depending on their commercial experience of the production of ferro-manganese in such a furnace. As, however, they have no data with regard to the production of pig-iron, they have accepted my figures for the probable consumption of power and charcoal in such a furnace. These assumptions, which are based on calculation, are that the open furnace would need 0.50 horse-power year of electric power, which is 0.05 more than I allowed for the Swedish furnace, and 0.50 ton of charcoal, which is 0.1 ton more than I allowed for the Swedish furnace.

Messrs. Beckman and Linden argued, from general considerations, that the open furnace would be at least as economical of power as the Swedish furnace, but were not prepared to guarantee such a performance. I do not think it will be safe to assume any better figures than those I have given until the performance of this furnace has been demonstrated in commercial operation over a considerable period. The figures they give for labor, general expenses, and interest are probably too high, because they are considering a single 3,000-kw. furnace, while the plant we have in view will employ about 10,000 kw. The output of the single furnace is taken as 8,000 tons per annum.

Beckman and Linden's Estimate of the Cost of One Long Ton of Foundry Pig-iron made in Open Furnace from a 50-per-cent. Ore*.

Iron ore, 2 tons at $4 per ton	$8.00
Electrical power, 0.5 horse-power year at $15	7.50
Charcoal, 0.5 ton at $6 per ton	3.00
Electrodes, 20 lb. at 10 cents per pound	2.00
Labour	8.00
Supplies	1.00
Plant and general office expenses	5.00
Interest and depreciation, 20 per cent. on $180,000	4.50
Total	$39.00

If we are considering this furnace as a unit in a plant of 10,000 kw., it seems probable that the cost of labour would be about $6, the general expenses $3, and the interest and depreciation $3. With these changes the total cost would be reduced to $33.50, or about $4 more than my estimate with the Swedish furnace.

Messrs. Beckman and Linden consider that using 50-per cent. ore at $4 they could obtain a 65 per cent. concentrate at $6.45 per ton, including the cost for concentrating and sintering of $1.25 per ton of concentrate. Using this concentrate, they estimate the following, assuming an output of 10,000 tons per annum from a 3,000 kw. furnace:

Beckman and Linden's Estimate of the Cost of Foundry from 65 per cent. Concentrate.

Iron, ore, 1.54 tons at $6.45 per ton	$ 9.93
Electric power, 0.4 horse-power year at $15	6.00
Charcoal, 0.5 ton at $6	3.00
Electrodes, 20 lb. at 10 cents per pound	2.00
Labour	6.40
Supplies	1.00
Plant and general office expenses	5.00
Interest and depreciation, 20 per cent. on $140,500	2.81
Total	$36.14

This estimate shows a saving of $3 as compared with the cost of smelting the undressed ore, but I am doubtful whether so small a degree of concentration would do more than barely pay for itself. Thus, even assuming the small cost of $1.25 per ton of concentrate to cover the crushing of the ore, the magnetic dressing, and the sintering of the concentrate, it appears that Messrs. Beckman and Linden have figured on a perfect dressing, losing no iron in the tailings. If we assume the latter to contain even so little as 15 per cent. of iron, we would need 1.43 tons of ore for each ton of concentrate, which with the above charge would work out at $6.97 per ton, or $10.20 per ton of iron. The difference in power-consumption of 0.10 horse-power year per ton was deduced from my own figures, but is probably rather too high; 0.075 would be a more probable estimate. A mistake appears to have been made in the item for interest and depreciation, which can hardly be reduced from $4.50 to $2.81 by the increased richness of the ore. I believe it would be found in practice that the enrichment of the ore from 50 to 65 per cent. would not effect any considerable saving. On the other hand, as I show elsewhere, if an ore of, say, 40 per cent. could be mined decidedly more cheaply per unit of iron contents than a 50 per cent. ore, a concentrate of 65 per cent. or upwards could probably be made from this cheaper ore at such a price as to offer a material saving. It should be added that the whole of the foregoing discussion depends upon the ease and completeness with which the ores of British Columbia can be concentrated. At present we have no information on this subject.

An examination of the above estimate will show that the consumption of iron ore must be taken as 2 long tons of 50 per cent. ore and 1.54 long tons of 65 per cent. concentrate respectively per long ton of pig-iron produced. They differ in this respect from my own estimates, which are in short tons of ore per long ton of pig-iron. My estimates were made in that way because the cost of ore, charcoal, etc., in British Columbia is quoted on the short ton, while pig-iron is always sold by the long ton.

For the purpose of this report, I furnished Messrs. Beckman and Linden with the following estimate of the commercial consumption of power and charcoal per long ton of foundry pig-iron made in an open-pit furnace. This estimate may be regarded as too conservative, but I have no data on which I could base a closer estimate.

	H.P. year.	Net ton Charcoal.
White charcoal iron from 65 per cent. concentrate	0.35	0.45
White charcoal iron from 50 per cent. iron ore	0.45	0.45
Grey charcoal iron from 65 per cent. concentrate	0.40	0.50
Grey charcoal iron from 50 per cent. iron ore	0.50	0.50

I have no reason for doubting the general correctness of these figures, which, of course, will vary with the size of furnace and operating conditions, but for purposes of comparison I would alter the power-consumption assigned to items 2 and 3 so as to make them equal. Thus the power-consumption for white charcoal iron from 50 per cent. ore and for grey charcoal iron from 65 per cent. concentrate would each be 0.42 or 0.43 horse-power year.

Comparison with Blast-furnace Methods.

It may be of value to compare with my estimate of the cost of making pig-iron in the Swedish furnace the following estimates by the B. L. Thane Company of the cost of making pig-iron in a large blast-furnace near Puget Sound at 1918 prices:—

B. L. Thane Company's Estimate of the Cost per Long Ton of Blast-Furnace Pig-Iron.

Iron ore, 3,457 lb. at $4.40 per long ton	$ 6.81
Coke, 2,485 lb. at $9.60 per net ton	11.93
Limestone, 1,000 lb. at $1.90 per long ton	.81
Labour	1.50

*It will be found that, making reasonable allowance for losses, the ore would have to contain about 55 per cent. of iron in order that 2 net tons of it should yield 1 long ton of pig-iron.

Materials	1.50
Capital charges	3.40
Total	$25.95

(1)—The charge for iron ore, $6.81, is less than my estimate of $8, merely because the ore is assumed to contain 65 per cent. of iron, whereas I have been advised that it will not be safe to assume more than 55 per cent.; the price per ton of ore being the same ($4.40 per long ton instead of $4 per short ton).

(2)—The charge for coke, $11.93, is more than the combined charges for charcoal, electrodes, and power, $11.15.

(3)—The capital charges are nearly the same, $3.40 and $2.50, or including the royalty, $3.10.

(4)—The electric furnace estimate is higher than the other on account of the heavy charges for labour, $4.50, and management $2, compared with the single item of $1.50 for labour in the blast furnace plant. This difference is caused mainly by the difference in the scale of operations; a coke blast-furnace turning out at least 300 tons of iron daily, while the electric furnace would scarcely make 30 tons.

In conclusion, there does not appear to be any cause, other than the different size of the furnaces, why electric-furnace iron should cost more than blast-furnace iron under the conditions we find on the Coast, and providing that power can be obtained at $15 or less.

Two other estimates by the B. L. Thane Company place the consumption of coke at 2,240 lb., costing $7.13 per net ton of coke, or $7.98 per ton of iron, and at 2,625 lb., costing $12.20 per net ton of coke or $16 per ton of iron; the total cost of a ton of pig-iron coming to $22 and $30.02 respectively.

Since the above was written I have received a letter from the British Columbia Electric Railway Company, which is reproduced in Appendix IV., stating in effect that they would supply large blocks of power up to 10,000 horse-power in the neighbourhood of Vancouver for a charge of 0.5 cent per kilowatt-hour. This charge is so high as to render impossible any large scale production of electric pig-iron in the Swedish or open-pit furnace, and unless some other method can be devised that will need decidedly less power, all that can be done will be to make a small amount of pig-iron during the present period of extreme high prices. In view of the necessarily temporary nature of such operation, it would be impossible to install a plant of Swedish furnaces, and we can only consider the simple open-pit furnace, because, although it uses more power per ton of pig-iron, it can be installed more quickly and more cheaply, and can easily be converted to the production of ferro-alloys, or even replaced by electric steel-making furnaces, when the drop in the price of pig-iron shall render its production impossible.

In calculating the cost of making iron in the simple pit furnace with power at 0.5 cent, I must, for comparison with the previous instances, convert this figure into a charge for the horse-power year. For this purpose I shall assume a load factor of 85 per cent., which provides for stops for repairs, as well as the usual degree of irregularity of power. On this assumption the horse-power year would cost $27.80. The cost of making a long ton of foundry iron in a plant of 10,000 kw. would be about as follows:—

Cost of One Long Ton of Foundry Iron using 0.5 Cent Power.

Iron ore, 2 tons at $4 per ton	$ 8.00
Electrical power, 0.5 horse-power year at $27.80	13.90
Charcoal, 0.5 ton at $6 per ton	3.00
Electrodes, 20 lb. at 10 cents per pound	2.00
Labour	6.00
Supplies	1.00
Plant and general office expenses	5.00
Interest and depreciation	3.00
Total	$41.90

With so high a charge for power the operations would probably be on a smaller scale, and it would be inexpedient to install as much labour-saving appliances, so that the cost would agree more closely with Beckman and Linden's estimate of $39, corrected for the higher price of power. This would come to $45.40 per ton of pig-iron. Thus it appears that unless cheaper power can be obtained the cost of making electric pig-iron in British Columbia will be in the order of $40 to $45 per ton.

The British Columbia Railway Company offer 2,000 kw. of $15 power on Vancouver Island, but this does not improve the situation materially, because the scale of operations would be so small that the cost of a ton of iron would certainly be in excess of $40.

It should also be noted that the above offers of power carry some restrictions with regard to the company's peak-load periods. I have no particulars in regard to this, but no doubt it would further increase the operating cost by reducing the output from a given electrical plant and staff.

PROBLEMS INVOLVED IN CONCENTRATION & UTILIZATION OF DOMESTIC LOW-GRADE MANGANESE ORE.*

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(This is a reprint of a paper presented at the February Meeting of the American Institute of Mining Engineers, held in New York.)

Introduction.

The steel industry of the United States has depended in the past almost wholly upon imports for its supplies of manganese. Many of the important domestic sources yield ores leaner in their natural condition than the foreign ores the steel industry has been accustomed to use. To make them available, therefore, either the ores must be concentrated or the practice of the steel industry modified.

Roughly 25,000 T. annually of high-grade manganese ores are used for dry batteries, for chemical purposes, and in other ways; while approximately 750,000 T. are required for making steel.

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† Formerly U.S. Bureau of Mines, Washington, D.C.

By present practice every ton of steel takes an average of about [illegible] of metallic manganese. This is generally added to the steel in the form of an alloy, the standard alloys being the 80-per cent ferro-manganese and the 20 per cent spiegeleisen. During the year 1917, 286,000 T. of ferromanganese and 193,291 T. of spiegeleisen were made in this country, the former largely from imported ores; and 45,381 T. of ferromanganese were imported. The metallic manganese represented by these alloys was 304,000 T., the product of roughly 800,000 T. of high-grade ore and 345,000 T. of low-grade ore.

It is hoped that certain modifications in steel practice may be brought about to the end that lower-grade alloys and more spiegel will be used, and that manganese will be conserved both in producing the alloys and in their utilization. It has been estimated that the 1918 output of steel will require 280,000 T. of metallic manganese, which, according to the program laid down, will consume about 750,000 T. of ores of sufficiently high grade to produce ferromanganese, and about 700,000 T. of low-grade ores suitable for making spiegel.

There is an abundance of low-grade ore in this country suitable for spiegel, but to make ferromanganese higher grade material is necessary. Hence the concentration of our domestic material presents a field for research and experimental work.

Manganese Deposits in the United States.

Before the war manganese ore was mined in relatively small quantities in the Appalachian region, including Virginia, Tennessee and Georgia, and in Arkansas, but owing to the increase in prices during the past three years manganese mining has been undertaken also in Montana, California, Arizona, New Mexico, Nevada, Utah, and Minnesota.

From data now available it appears that in this country deposits of high-grade manganese ores are usually small, while materials lower in manganese and higher in iron occur in appreciable quantities. Our total quantity of manganese-bearing material is relatively large, but on account of the difficulty of mining small deposits and the apparent undesirability of the low-manganese material in the steel industry many difficulties present themselves.

Manganese bearing materials of the United States may be roughly classified as follows:

1. Manganese ore proper.
2. Manganiferous iron ore.
3. Miscellaneous material.
    (*a*) Manganiferous silver and lead ore.
    (*b*) Zinc residium from manganiferous zinc ore.

Manganese ore as now defined by the trade is material containing over 35 per cent manganese and suitable for the manufacture of 70 per cent ferromanganese. Manganiferous iron ore contains less manganese and more iron. Usually iron predominates, but there is no hard and fast line of demarcation between manganese ore and manganiferous iron ore. Manganese and iron are usually closely associated in nature, and all gradations from very low manganese ores with high iron, to high manganese ores with low iron, may be met in various deposits or in the same deposit.

Manganiferous silver ore is similar to manganiferous iron ore, there being sufficient silver to make it valuable for that metal. It may be used for the production of manganese alloys and commercial considerations alone control the balance between the manganese or the silver value.

Zinc residuum is a byproduct from the smelting of certain zinc ores of Franklin Furnace, N.J., which contain considerable manganese. After the zinc is removed the remaining product, called residunm is of nearly the same composition as natural manganiferous iron ore, and for a number of years has been used for making spiegeleisen.

Metallurgical Requirements of the Steel Industry.

Manganese is principally used in the steel industry in the form of manganese alloys. A less important use is for increasing the manganese content of certain pig irons to give them particular qualities, as for foundry purposes, or to assist in metallurgical operations of certain steel-making processes ,as in the basic open-hearth process. The alloys of manganese generally used in this country are ferromanganese, formally containing 80 per cent, but now 70 per cent metallic manganese, and spiegeleisen, containing from 15 to 20 per cent metallic manganese. The remaining content of these alloys is principally iron with small quantities of carbon, silicon and phosphorus.

For the past few years ferromanganese has been gaining in popularity with steel manufacturers, spiegeleisen declining proportionately. Until recently approximately nine-tenths of the metallic manganese used in the steel industry was in the form of the standard 80 per cent alloy. "Ferro," as it is usually called, is easier to use than alloys containing smaller quantities of manganese, as the required quantity of that metal is contained in smaller bulk.

The difficulty of obtaining ores suitable for the production of "ferro" during the past few years, has led to the consideration of using what may be called intermediate alloys with manganese contents varying between 20 and 80 per cent. In the electric furnace certain alloys can be made with a relatively large content of silicon in addition to the manganese and iron. The extent to which such alloys may satisfactorily be used in steel manufacture is not alone a technical or economic problem, but is largely controlled by the prejudice of steel masters against deviating from established practice.

Phosphorus is an undesirable element in finished steel. In the manufacture of manganese alloys all the phosphorus contained in the ore will enter the alloy and will be introduced into the steel when the alloy is added. It is permissible, however, for an alloy high in manganese to contain more phosphorus than one low in manganese, for in the former case less alloy is needed to introduce a given quantity of manganese.

For many years manganese alloys have been principally manufactured in the blast furnace, although recently certain plants have produced them in the electric furnace. The operation of a blast furnace on manganese alloys is in general similar to ordinary pig-iron practice, but there are high metal losses, principally in the slag and in the stock. The manganese content of the slag may be partly controlled by furnace manipulation, but it is evident that the total loss in this manner is directly proportional to the slag volume.

The results of increased slag volume are cumulative and serious. The accompanying increased loss of manganese requires that more ore be used per ton of alloy produced. The additional ore introduces more slag-forming constituents, requiring more coke to melt it, which in turn tends to produce more slag, while increased slag volume cuts down the daily output of alloy. The greater manganese loss decreases the ratio of manganese to iron in the alloy and unless proper allowance is made the alloy will be below the standard grade and therefore subject to penalty by the purchaser. Not only will the alloy sell for less, but the decreased daily output will lessen the total profits.

The alloy manufacturer endeavors to protect himself against these decreased profits by adjusting schedules for ore purchase. Although the endeavor is made to equalize the effects of poor ores in furnace practice, the alloy producer would prefer to buy better ores and pay correspondingly more, whenever they are available. The subject of prices and schedules has already been fully discussed in the introductory chapter of this series by Mr. C. M. Weld.[1]

Concentration of Domestic Low-grade Manganese Ores.

The comprehensive term, concentration, as here used is intended to include the improvement of low-grade material by any suitable means preliminary to smelting. The requirements of metallurgical practice control the classification of manganese materials into low-grade and high-grade. In some cases, the term low-grade may refer to a low manganese content with respect to iron or to large quantities of non-metallic impurities. The detrimental effect on metallurgical practice and resulting penalties offers the incentive for attempts to improve the material or raise the grade before smelting.

Factors Controlling the Possibilities of Concentration.

In order to properly interpret the possibility of commercially concentrating any type of manganese-bearing material, it is necessary to consider many technical and economic factors. For a particular property, district, or class of material it is necessary to obtain data on the following factors:

1. Character and size of the deposits.

2. Conditions affecting mining and marketing.

3. Character of ore material as affecting the possible improvement of grade.

4. Metallurgical value of crude ore and possible concentrate.

5. Commercial considerations.

Size and Character of Deposit.

Obviously a deposit containing a large quantity of low-grade ore would warrant considerable experimental work in order to determine methods of treatment. Conversely, if a particular type of material occurred in only one deposit and contained but a few thousand tons, it is evident that the value of the product to the industry at large would be relatively small, even if it were possible to concentrate it. Therefore proper perspective should be obtained in order that no undue proportion of time be devoted to a concentrating problem which may be of considerable technical and individual interest but which would assist little toward furnishing any considerable portion of the industry's needs.

In other words, the mineralized mass must be of such size and character as to justify the expenditure of money in its development and beneficiation and return interest on the investment proportional to the risk taken. This factor is of vital importance, and it is feared that under the stimulus of production incident to national needs during the war, sound business principles have at times been overlooked.

Conditions Affecting Mining and Marketing.

In addition to the classification of deposits on the basis of quantity and character, it is necessary to determine the natural factors controlling mining methods, transportation facilities and marketing.

The manganese deposits of the United States, while widely scattered and comparatively small, may nevertheless be mined by relatively simple and therefore cheap methods. The mines are for the most part shallow, so that extensive, non-productive development and elaborate equipment are not necessary. Intricate problems of ventilation and drainage have not to be solved, and if all operations are competently directed, common mine labor will generally suffice. Limited tonnage means short life, and temporary support of excavations following more or less crude mining practice prevails. The cost of mining, however, will be more or less governed by the necessity of selective mining which in turn is determined by the variability in character of the ore, the feasibility of economic concentration, the transportation facilities and the distance from a consuming center. All these factors must be properly co-ordinated and their combined influence studied before intensive production from individual properties is started. By the elimination of waste, concentration may yield a product desired by the steel industry, but the cost may be prohibitive. The reduction of weight resulting from waste discard may enable the producer to offset excessive freight rates, but geographic isolation will invariably handicap an enterprise. Foreign ores will always find a market in the United States since the deposits from which they come are larger and more uniform in character while the wage scale is low, and railroad transportation can never compete with ocean freight.

Characteristics of Ore Affecting Beneficiation.
Character of Manganese Minerals.

There are a great number of minerals containing manganese, but relatively few that are commercially important. Usually it is rather difficult to identify accurately the manganese minerals contained in domestic oxidized ore. Several minerals may occur in more or less intimate association, and in some cases one has been formed by alteration of another. The hardness of the individual minerals varies widely. Pyrolusite is soft and may be readily pulverized between the fingers. Difficulty might be expected, therefore, in attempts to recover this mineral by the common processes of wet concentration. The other minerals are harder but usually brittle. While the character of the individual minerals is important, the association of the several manganese minerals with the gangue materials and the relation thereto often has a more important bearing upon the problem of concentration.

[1] U.S. Bureau of Mines———. Paper No.—

Impurities Associated with Manganese Minerals

Manganese ores mined on a commercial scale always contain impurities. The presence of some of these will be obvious by simple inspection, while others may require chemical analysis for their determination. The impurities associated with manganese minerals may be classified as: (1) Those derived from associated rocks or rocks partially replaced by manganese-bearing solutions, (2) those associated with the manganese in solution and deposited simultaneously, and (3) those chemically combined with manganese in the mineral. From the metallurgical viewpoint all are impurities and must be removed either before metallurgical treatment or by it.

For convenience the common impurities in manganese ores may be classified according to certain general physical and chemical principles as follows:

1. Metallic: Iron, lead, zinc, silver, and in some cases, nickel, copper and tungsten.

2. Gangue: "Basic" lime, magnesia, baryta, "acid" silica and alumina.

3. Volatile: Water (atmospheric moisture and molecular water), carbon dioxide, organic matter.

4. Miscellaneous: Phosphorus and sulfur.

The chemical behavior of these impurities affects metallurgical operations, while the physical form in which they occur controls the possibility of removal previous to smelting, and the choice of methods of removal.

The proportion of manganese to useless or harmful constituents of the ore determines its value and desirability. The presence of appreciable quantities of any impurity means that more ore must be mined and smelted to produce a given weight of alloy. Some impurities, however, are more detrimental than others.

Metallic impurities, of which iron is the most common, will usually be reduced and retained by the alloy. The quantity present controls the desirability of the alloy for use in steel manufacture. Metallic impurities other than iron occur usually in such small quantities that they are not detrimental to the resulting alloy. Zinc is an exception; it is largely volatilized in the smelting and, if present in appreciable quantities, the fume will condense as oxide in the hot-blast stoves, which may interfere with furnace operations. Unless the furnace top gases are washed the stoves must frequently be cleaned, with consequent loss of time. When the price of zinc is high the zinc oxide recovered from the stoves yields a substantial sum. Silver is neither detrimental to manganese alloys from the standpoint of steel manufacture nor advantageous. The silver content of a manganese alloy has no value, consequently no credit is allowed the miner for silver contained in an ore when it is to be used for manganese-alloy manufacture. In some cases the quantity of silver in a manganiferous ore is such that it has greater value for the lead smelter. The manganese then acts as a flux.

The gangue impurities classed above as basic and acid may also be called slag-forming impurities. In smelting these impurities must be fluxed to form slag. Slag is usually considered a waste product of a smelting operation, but it has important metallurgical functions, and just sufficient slag must be present to perform those functions properly and economically. An excess of slag must be avoided. In manganese-alloy manufacture the slag contains more or less manganese which does not enter the alloy. The quantity of manganese thereby lost is dependent upon the basicity of the slag, the temperature, and the slag volume. The first two factors control the quantity of manganese in a given weight of slag, while it is obvious that a greater slag volume will result in a greater loss of manganese.

Silica is usually the predominating slag-forming constituent in domestic manganese ores. A certain quantity of silica is reduced to the metallic state in the smelting operation and is recovered in the alloy as silicon, but the larger part must be fluxed with lime, magnesia or other bases to form slag. Manganese-alloy slags should be basic, hence a larger quantity of slag will be produced from an ore with acid gangue than in normal iron blast-furnace practice. Alumina is a slag-forming constituent, and while usually classed with silica, it acts somewhat differently in blast-furnace operations. Brazilian ores are notably high in alumina, but most domestic ores contain relatively small quantities.

Lime, magnesia and baryta in an ore are also slag-forming constituents, but they combine with the silica and alumina present and thereby reduce the quantities of these bases necessary in the form of limestone or dolomite for the furnace charge. Baryta is not common as a gangue mineral. It is not so strong a base as either lime or magnesia. While these constituents offset the metallurgical effects of silica or alumina, from the standpoint of evaluating an ore they represent weight, and if the ore must be transported a considerable distance to be smelted, it is doubtful whether their value as bases would equal the additional freight charge. Limestone can generally be obtained at low cost close to the smelter.

Volatile impurities are removed from the top of a blast furnace largely by the surplus heat. It is desirable, however, in order to reduce the loss of manganese from this cause to keep the top of a manganese-alloy blast furnace cool. Volatile compounds are not particularly detrimental to smelting. When carbonate ores are being treated the case is somewhat different, some metallurgists claiming that in treating rhodochrosite ores the ratio of carbon monoxide to dioxide in the furnace gases is disturbed, which has a detrimental effect on the reduction of the oxides of manganese in the upper part of the furnace. It has also been suggested that the carbon dioxide driven off combines with carbon of the coke, forming carbon monoxide in the upper part of the furnace, and thus increases the coke consumption. Definite data are not available on these points.

From the practical standpoint all the phosphorus in the ore mixture, together with that contained in the coke and limestone, is recovered in the resulting alloy. The permissible quantity of phosphorus in an alloy such that it does not produce detrimental effects when added to steel has not been definitely determined. The higher the manganese content of an alloy, the larger the quantity of phosphorus that may safely be contained. Ordinarily steel makers desire as large a margin of safety as possible and therefore have specified that phosphorus shall not be above a certain percentage in an ore.

Sulfur usually exists in relatively small quantities in oxidized manganese ores, but in the case of the primary rhodochrosite ores of Butte and other parts of the West there may be present considerable quantities of sulfides of iron and zinc. Sulfur is not a serious fac-

tor, as the conditions of blast-furnace operation, when making manganese alloys, are such that sulfur combines with manganese or lime and is readily retined by the slag, only traces entering the alloy.

Knowing the effect of impurities in manganese ores on blast-furnace practice, the methods of eliminating them may be considered. Ore-dressing deals with the separation of deleterious or useless materials from the more valuable minerals, thereby raising the grade and reducing the quantity of the concentrated product. To accomplish this it is essential that the physical and chemical characteristics of the ore be determined. These factors are governed largely by the type of deposit from which the ore is mined. As types of ore, entirely disregarding genesis, we recognize:

1. Rhodochrosite and rhodonite; carbonate and silicate ores, deposited in fissure veins or replacing original rocks.

2. Nodular ores: accretions of manganese oxide in soft plastic clays.

3. Manganese oxides deposited in small fissures or fracture planes, as breccia fillings, or as more or less impure beds.

4. Manganese oxides occurring as infiltrations, deposited in minute pore spaces, as particle replacements, or otherwise intimately mixed with the rock or gangue.

In the first class of deposits the principal gangue impurity is silica, although sulfides of silver, lead, zinc and iron are often found in appreciable quantities. The silica occurs both as quartz and chemically combined in rhodonite ores. In the carbonate ore, the carbon dioxide may be removed by calcination, thus effecting a concentration, but rhodochrosite decrepitates strongly when heated to a temperature where the oxide is formed, tending to produce an excessive quantity of fine material which is undesirable in practice. The breaking up of the particles by calcination will isolate some of the free silica, which on account of its larger sized particles may be screened out. The sulfide minerals may occur in such quantity that it is desirable to remove them by gravity methods of separation.

In the second class of deposits the nodules are of variable size and usually high in manganese. They do not appear to be contaminated internally with the inclosing material. The clays are soft, whereas the nodules are generally hard. This type is common in the Appalachian region of the United States. The clay may be separated from the manganese nodules by means of log washers, followed, where necessary and where the size of the deposits warrants the installation, by picking-belts, crushers, screens and jigs.

With deposits of the third class the manganese minerals, although closely associated with the inclosing rock, are not generally contaminated by it and may be relatively pure. The method of treatment will vary with the size of the manganese particles and the hardness of the rock but will not differ essentially from the treatment of the second class. If there is little or no clay, the log washer will be omitted, while crushing, screening, jigging, and possibly tabling will make up the concentrating process.

It should be noted that if the mineral is largely pyrolusite, and therefore friable and soft, crushing may produce an excessive quantity of fine material, composed of manganese minerals which are difficult to recover by means of gravity or water methods of separation. If, however, the manganese mineral is of a hard, dense, massive variety, and the inclosing rock more friable, the problem is simpler. When the specific gravities of the minerals and the gangue approximate each other wet concentration is difficult unless there be a marked difference in the size of particles.

From the standpoint of concentration it is obvious that the association of gangue materials with the desired mineral in ores of the fourth class is so intimate that the finest crushing imaginable would not permit of separation by mechanical means. To this type the siliceous manganese ores of the Western States may be assigned. Ore-dressing experimentation has conclusively shown that where the silica is chemically combined with the manganese or where colloidal silica envelopes the manganiferous particles, wet-process or gravity concentration will not give the desired results.

Concentration of Manganese Ores.

It is not within the scope of this paper to describe in any detail actual ore-dressing or concentration practice. It is axiomatic that small deposits or mines of questionable life do not warrant elaborate plans or the adoption of intricate beneficiation processes. A general classification of methods applicable to the manganese industry is given below. These are all preliminary to the greater and final concentration of the desirable elements in the blast furnace from which the ferro-alloy is produced.

Simple Methods of Concentration:

(a) Selective mining.
(b) Hand picking.
(c) Jigging.
(d) Screening.
(e) Log washing.
(f) Water classification.
(g) Roughing table treatment.
(h) Slime table or vanner treatment.
(i) Pneumatic separation.
(j) Combination of two or more of the above.

Complex Methods:

(a) Magnetic separation:
  1. Without preliminary thermal treatment.
  2. With preliminary thermal treatment.
(b) Electrostatic separation.
(c) Hydrometallurgical processes:
  1. Leaching with various acids. Precipitation by chemical substances.
  2. Leaching with various acids. Precipitation by electrolysis.
  3. Leaching with various acids. Evaporation of solution and heat treatment in rotary kiln.
(d) Preliminary thermal processes:
  1. Drying, to remove hygroscopic moisture.
  2. Calcining, to remove carbon dioxide or combined water.
  3. Agglomerating fine concentrates to make them desirable for blast-furnace use.
  4. Volatilizing manganese at high temperatures in the presence of certain constituents which form readily volatile compounds.
  5. Direct reduction of oxides by carbon, under temperature control.
(e) Miscellaneous processes:
  1. Flotation.
  2. Use of heavy solutions.

There are many standard machines for the concentration of ores based on certain principles or combinations of principles, but it is unwise and usually unsatisfactory to begin with the idea that a certain machine will accomplish the necessary result on manganese-bearing materials. As the character of the manganese materials varies greatly in different districts, it is more logical to determine first the detailed physical and chemical characteristics of the material. When such preliminary study has shown the nature of the impurity and its relationship to the manganese mineral, it is easier to outline the general methods of treatment which might reasonably be expected to accomplish the desired result. The flow sheet, however, must be determined by experimental work.

Commercial Considerations.

If the technical possibilities of beneficiating an ore have been favorably determined, it is then necessary to ascertain whether such an operation could be conducted on a commercial scale and a reasonable profit made. The cost of the plant and its installation must be justified either by the available ore, or upon the length of time during which the profit could be made. The amortization of capital and interest on the investment must be included in the estimation of cost.

The effect of concentrating an ore is not always clearly appreciated. Concentration implies that an improvement of metallic content is made by the intentional elimination of impurities, but by so doing there is always a loss of the valuable mineral itself. When the grade of material is increased, the weight is decreased. In other words, in some cases from 2 to 25 T. of crude material may be necessary to produce 1 T. of high-grade concentrate. The income results from the sale of the smaller quantity of concentrate, but chargeable against this, will be the mining cost of the several tons of crude ore necessary to make that concentrate, the actual cost of treating the ore, the freight to market, and special overhead charges. Concentration may be necessary, however, to make the material marketable at all.

SHIMER CASE-HARDENING PROCESS.

By JOSEPH W. RICHARDS,* Bethlehem, Pa.

(New York Meeting, February, 1919.)

There are two essentially different types of case-hardening processes; that using a dry mixture in which the object to be case-hardened is packed and kept for the necessary time at the necessary temperature and the "liquid" process, employing a bath of fused salts into which the object is immersed and which by immediate contact case-hardens the surface of the article. The Shimer process belongs to the second class.

Of the liquid melts used as baths, the most effective and most frequently used are melted potassium cyanide and melted sodium cyanide. These may be used either pure or mixed with salts that reduce the melting point and the percentage of cyanide present. The use of these baths since 1914 has met many commercial difficulties because of the high price and frequent commercial scarcity of the cyanide salts; at present sodium cyanide has practically entirely displaced potassium cyanide. Another trouble is the danger to the workmen handling the cyanide salts, which are extremely poisonous, and the annoying and poisonous vapors or gases given off in the workshop, unless an effective system of hoods and ventilation is provided, so as to prevent the gases from the baths mixing with the air of the room.

Porter W. Shimer, of Easton, Pa., has invented a substitute[1] for the bath of melted cyanides which case-hardens with equal or greater facility and effectiveness, gives off no poisonous vapors, and costs for chemicals but a fraction what the cyanide costs in the previously used baths. The process has been in use over a year in a large American works, and the following statement embodies the results of practical experience in the use and operation of the process.

The Shimer liquid or melted bath consists of a mixture of easily fusible salts that do not possess case-hardening properties, into which is immersed fresh calcium cyanamide, which imparts to the bath case-hardening properties. The composition of the non-case-hardening salts appears rather immaterial. Good results have been obtained by using a mixture of sodium chloride, calcium chloride, and barium chloride in equal proportions by weight; also a mixture of one part sodium chloride to one part calcium chloride. Potassium chloride can replace the sodium chloride where the question of cost is not material, producing a very liquid bath when equal chemical parts of the two salts are used—that is, 58.5 parts of sodium chloride to 75.5 parts of poatassium chloride. Alkaline carbonates or alkaline hydroxides have also been added to the bath material with advantage in some special cases.

The mixture of non-case-hardening salts is melted in an iron or steel pot suitable for case-hardening operations, and the calcium cyanamide is brought into contact with it, which may be accomplished in several ways. One very effective method is to place small lumps of the cyanamide in an iron basket, which is sunk to the bottom of the case-hardening pot. A lively evolution of gas soon takes place, the exact composition of which has not yet been fully determined. The bath quickly acquires case-hardening properties, which last as long as the evolution of gas continues. What the exact chemical reaction of the cyanamide upon the non-case-hardening salts is, to produce a melt that has excellent case-hardening properties, has not yet been determined; it would need thorough and arduous chemical investigation to precisely illuminate the rationale of the operation. The fact remains, however, that contact of the cyanamide with the other salts imparts to the liquid bath active case-hardening properties.

In practice, the calcium cyanamide is immersed in the bath of melted salts and as soon as a lively evolution of gas is shown, the dipping in of articles and their case-hardening can be proceeded with. If the evolution of gas becomes too active, the cyanamide may be removed and case-hardening can be proceeded with for some time after this removal. When the case-hardening power of the bath decreases, the cyanamide may be re-immersed and the operation continued as before. If the cyanamide is in large fresh pieces and the evolution of gas is not too violent, the cyanamide may be left permanently in the bath until it has lost its power of imparting case-hardening properties to the melt, as is shown by the diminution of the evolution of gas. On removing this apparently exhausted material, the lar-

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[1] U.S. Patent.

ger pieces may be broken, thus exposing fresh surfaces, and the material will be found to still retain active properties when re-immersed in the bath.

It has been found that cyanamide is best used in lumps varying from the size of a walnut to the size of an egg. If fine powder is put into the bath, it is difficult to keep the powder immersed, and the frothing is voluminous and troublesome. If the cyanamide has been exposed to air, absorbing moisture and becoming oxidized, it causes violent frothing when immersed in the bath, which continues an inconveniently long time. If only such cyanamide is available, it may be mixed with pulverized hard pitch or with tar, and the mass coked at a red heat; this eliminates absorbed moisture and changes the structure from powder to a porous coke. Such porous coke is then used in the melted salts in exactly the way that has been described for solid lumps of fresh calcium cyanamide. Arrangements have been made with the manufacturers of calcium cyanamide to select high-grade cyanamide for the purpose of this process, and to transfer it directly from the furnace in lumps of desired size to air-tight containers, so that its use in the process will always be at a maximum efficiency.

The quantity of cyanamide immersed may vary according to the size of the bath and the shape, size, and character of the articles to be case-hardened. A bath may have immersed in it 5 per cent of its weight of the fresh calcium cyanamide, or a corresponding quantity of the cyanamide coke, for ordinary work.

Upon removal from the bath, the case-hardened articles are quenched in a suitable cooling liquid as in ordinary case-hardening practice.

A careful estimate of the relative cost of running with the sodium cyanide at normal market prices and calcium cyanamide as described, extending over more than a month's work in a large plant, shows the cost of the bath material to be approximately one-fifth as much when using calcium cyanamide as when using sodium cyanide, with the case-hardening done in an equally satisfactory manner, and with much more comfortable and healthful conditions to the workmen.

The question of the scientific basis of the process is being investigated by the inventor, and may form the subject for further communication to the Institute.

VANCOUVER STRONG AFTER NEW DRY DOCK.

When the report came from Ottawa that wires were being pulled to have the proposed dry dock built at Esquimalt, on Vancouver Island, Vancouver began to wake up in earnest and now there are one or two apparently definite plans under way to show why Vancouver should get this dry dock instead of Esquimalt.

As soon as this report regarding Esquimalt reached Vancouver different parties interested in having the proposed dry dock in Vancouver immediately got busy. Mayor Gale came forward with a plan whereby some financiers and experienced dry dock builders of Seattle who were conceded to be responsible parties, were anxious to build a $4,000,000 dock here in Vancouver. That is, providing a federal subsidy and a Provincial bond guarantee is forthcoming. The Mayor and Representatives from Vancouver had a conference with Premier Oliver and Attorney-General Farris at Victoria at which they placed their plans before the Provincial Officials and they stated they would do everything possible to facilitate the construction of a dry dock somewhere on the southern coast of British Columbia.

Meantime information has been received that no definite plans had been made and no plans had been filed with the Department at Ottawa for a dry dock.

Mr. S. McClay, Harbor Commissioner, has a scheme whereby it would be unnecessary for Vancouver to go outside for capital to build a dry dock, as he figures that enough money can be raised right among the citizens in Vancouver to carry out the scheme. Mr. McClay's idea is that it would be a mistake to build a floating dry dock as the specifications of the British Admiralty clearly favor the construction of a solid or graving dock instead. Moreover, a graving dock, once built, would be here for good, whereas a floating dock could be towed away to some other point if thought convenient.

A dry dock built by local capital would assure employment of local labor and material and would make many citizens shareholders in the undertaking.

No doubt the proposed dry dock will materialize at an early date somewhere on the southern coast of British Columbia, whether it will be on the mainland or Vancouver Island is problematical. Esquimalt already has a dry dock and this, no doubt, will argue against its securing another one. Another item is that material has to be transported across the Gulf, whereas Vancouver, being on the mainland, has this much in its favor.

STEEL RUDDERS FOR U.S. WOODEN SHIPS.

Seattle shipbuilders have been notified by the United States Shipping Board that all wooden ships now building are to be equipped with steel rudders. Captain W. A. Magee, Assistant District Manager in charge of wood ship construction, brought this word back recently. The reason for this is because of the trouble experienced with vessels built on the Atlantic, Great Lakes and Gulf Coasts, where the shipyards were not supplied with the oriental iron wood used in construction of rudders at Pacific Coast yards. It was decided, however, to make the order general, which is to include the Pacific Coast plants as well. Vessels already built will not be supplied with rudders of steel. Rudders of vessels already built and in commission will be reinforced as soon as the docking of these vessels is practical. All wooden ships on the ways will be completed for the United States Shipping Board, but nothing definite can be learned regarding plans after that.

OUTPUT OF PIG IRON IN CANADA.

The total 1918 output of pig iron from Canadian blast furnaces, and also from scrap metal melted in electric furnaces, is estimated by the Division of Mineral Resources and Statistics, Mines Branch, at 1,182,000 tons, of which 29,000 tons was electric furnace pig iron.

The total production of steel ingots and castings is estimated at 1,910,000 tons, which includes 125,000 tons of steel made in electric furnace plants and 1,785,000 made in open-hearth and other steel furnaces. The total production of steel ingots and castings in 1917 was 1,745,734 tons. The production of electric furnace pig iron in 1917 was 13,691 tons and that of steel in electric furnaces in the same year was 50,467 tons.

MACHINERY EXPORTS.

The testimony of those who have studied conditions in France at first hand is very clear that what France will require of us is machinery and equipment rather than raw and partly manufactured goods. The French have a tremendous task of reconstruction, or "reconstitution" as they call it, ahead of them, but instead of having unlimited funds and man power for doing the work their resources are very limited.

Taking iron and steel in particular, the French will not call upon the United States for pig iron, for unfinished steel or for finished rolled steel. A few lots of finished steel that have been taken as substitutes for war steel, by the terms of the contract, are distinctly the exception to the general rule. The French are very ambitious as to the manufacture of steel. Just before the war there was a great expansion, particularly in the North, many new blast furnaces having been built, and now, with control of the entire Minette ore deposits assured, except the limited portion of the field lying in Luxemburg, there is a disposition to expand still more in this respect. By reason of the damage done to French works in the portion of Lorraine so long occupied by the Germans, the actual capacity for production at the moment is doubtless less than before the war, despite the new construction elsewhere during the war, but instead of importing pig iron and steel the French will devote their energies to establishing facilities for the manufacture of these materials. For this purpose much machinery and equipment may be required. Possibly the amount will not be very large, but it is quite certain that it is machinery and equipment for making and finishing steel, rather than the materials themselves, that the French will want.

Somewhat the same condition exists in South America and elsewhere. These countries are not likely at once to embark in an extensive building or construction program, which requires much capital, but in all countries there is a desire to work and make money. For this, machinery is requisite.

The condition before the war was that, roughly speaking, the value of the iron and steel manufactures exported was about double the value of the iron and steel exported, that is, the value of exports of machinery of all sorts, agricultural implements and manufactures generally involving iron and steel, was about double the total value of exports of scrap, pig iron, unfinished steel, rolled steel and wire, pipe and similar materials that are commonly recognized as steel mill products. For some time to come the proportion will probably be still higher than two to one. Eventually, when it is possible to finance large undertakings abroad, railroads, power stations, bridges and the like, there may be a larger proportion of the ordinary rolled steel products, such as structural shapes, rails, sheets, pipe, etc., but that is for a period beyond the period in which the world's business is now.—American Metal Market & Daily Iron & Steel Report.

MANGANESE MINING CEASES.

From Missoula, Montana comes a report that a little strip of ground about one and one-quarter miles long and one-half mile wide mined over forty-five per cent of the gross of manganese produced during the war period. This is according to United States Geological Survey. From the little town of Phillipsburg, which is a part of this strip, poured a constant stream of this precious war metal which was sent to the mills throughout the States where the instruments of war were produced. The production of raw material from this district will probably exceed 200,000 tons.

EDITORIAL

A FOREWORD.

Under new editorship "Iron & Steel of Canada" will endeavor to maintain the tradition created by Dr. Stansfield and Mr. Dauncey, under whose guidance the paper has represented Canada's premier industry from a national standpoint.

The possibilities of iron and steel manufacture in Canada were partially demonstrated during the years 1915 to 1918, when some slight foreshadowing of the great future of the steel industry and its outgrowths came about through the insistent need for munitions of war.

The extent of the steel industry to-day in any country is a fair index to that country' progress in the arts, and no country can be truthfully termed independent—either economically so or from the standpoint of military defence—which does not possess the basic natural resources of coal and iron necessary for steel manufacture and fabrication.

The non-utilization of natural resources is tantamount to their non-occurrence, and while the steel industry in Canada is to outward appearance a sturdy growth, its future cannot but cause anxiety amongst those whose livelihood and investments are dependent upon it, so long as practically all the iron ore used in Canadian blast furnaces, a large part of the fuel used in smelting the ores, and virtually all the manufactured refractory materials used for linings in furnace processes and in coke ovens are imported from non-Canadian sources.

Our steel industry cannot be regarded as self-supporting until a much greater development of native ores, coal deposits and local sources of refractory materials has taken place than is now the case.

In the matter of iron ores, coal seams, and possibly in suitable clays, Canada may be poorly provided when compared with the United States, whose vast resources of these materials may be justly regarded as phenomenal. But it cannot be said that our home resources have been exhaustively examined, and it is certain that the presence of cheaper and more accessible materials across the border has retarded the investigation and the commercial testing of Canadian materials of similar kind.

"Iron & Steel of Canada" will endeavor to give publicity and aid to all that goes to render our iron and steel industry self-contained and nationally independent, and we shall be pleaded to receive contributions descriptive of such endeavors, no matter how small or apparently trifling, because the significance of endeavor does not reside altogether in its magnitude.

Original articles descriptive of new plant and improvements or innovations in practice will be very welcome, and we would venture to point out that at some Canadian plants, which labor under an unavoidable handicap in the first cost, or the character of the raw materials, economy in practice and a full utilization of by-products offer the only chance of commercial survival. We therefore invite contributions from practical men engaged in the industry and the free exchange of ideas.

"Iron & Steel of Canada," representing the comparatively small industry of this country, cannot hope to present the array of facts and news that characterizes such United States trade papers as the "Iron Age," but still there is a great deal occurring in Canadian steel circles that interests our readers, and we suggest that in no more effective way can they increase the value and readability of this periodical than by sending items of local interest for publication.

As compared with our friends across the line, while we are small in the extent of our steel tonnages and plant equipment, it is because we are passing through the early stages of our national growth, but our potentialities are not small, and we trust to see this periodical extend in circulation, scope and influence coincidently with the industry it will endeavor to represent.

WORKMEN'S COMPENSATION IN NOVA SCOTIA.

The Report of the Workmen's Compensation Board of Nova Scotia for 1918 is of interest to the iron and steel industry, inasmuch as two large steel makers, the Dominion Iron and Steel Company and the Nova Scotia Steel & Coal Company, come under the jurisdiction of the N. S. Board, and the 1918 Report, being the report for second year of the operation of the Act, is the first to contain any detailed statistical information.

The invested reserves of the Board at the close of 1918 totalled $1,586,000 par value, and the large difference between the receipts of the Board when compared with actual disbursements has given rise to some rather ill-informed criticism of the policy of the Board in the matter of collections and assessment rating. The real test of the efficiency of the Board is to be seen in the cost of administration, which reached only $49,448.36, or about 3.85% of the assessments collected. It may be remarked, however, that this cost of administration does not include the salaries of the three members of the Board, which are borne by the Government of Nova Scotia.

If the assessments and the required reserves are correctly calculated—and there is no reason to believe they are not, as these are all matters of actuarial ascertainment capable of very exact calculation — the

only expenditure collected by the Board over and above its past and future disbursements is the cost of administration.

We believe that in some instances the assessment rate can be reduced considerably. For example, owing to the occurrence of two colliery explosions in Nova Scotia the rate for coal mining was made 4.40 per cent. of the payroll. It has been found possible to reduce this to 3.00 per cent., which includes a disaster reserve, but there is good reason to believe that a rate of 2.50% will eventually be found to provide sufficient to cover the cost of workmen's compensation in coal mining. The Board announces further that the experience in the Iron and Steel class has been so favorable as to justify some reduction in assessments, but the figures are not given in the Report. A particularly favorable showing has also been made by the Transportation class, and here the rate is reduced from 4.50 to 2.50 per cent.

Of the total assets of the Board, namely $1,682,462.35, no less than $1,334,000 is invested in War Loan securities, the bulk being in the 1933 and 1937 Victory Bond issues. At the presently quoted price of these issues the original investment of the Board shows a very nice appreciation in value.

Under the provisions of the Nova Scotia Act, the employers can, if they desire, form a Safety Association, the expenditures in connection with which may be paid out of the funds at the disposal of the Board. Such an Association has recently been formed. This Association may recommend to the Board the adoption of certain safety measures, which, if approved by the Board, become mandatory upon employers within the class affected by the recommendations. The new Association is very well officered, and its progress, and the effect of its work upon the number of accidents will be watched with interest.

METALLOGRAPHY LABORATORY COURSE AT AT McGILL UNIVERSITY.

A course of practical instruction in Metallography was given during the past Session by Messrs. C. F. Pascoe and H. J. Roast. A number of men interested in this subject attended the Course, which was pronounced a great success. Requests have been made for an extension of this Course during the summer months, but this has been found to be impracticable, and those who wish to continue their studies or to take it up for the first time, should make arrangements to join in the fall. The accommodation is necessarily limited, and in consequence, it is desirable that those who wish to join should make application as soon as possible either to the gentlemen above named or to Dr. Alfred Stansfield, Professor of Metallurgy, McGill University.

JUSTICE TO OUR NATIVE YOUNG MEN.

The following letter is reprinted—in part—from the "Mining and Scientific Press," and regarding it the Editor of that admirable publication remarks that the writer is a lady, and probably the mother of sons, for which reason he welcomes her expression of opinion as reasonable and well worthy of sympathetic consideration.

The policy suggested by this lady is well worth consideration by Canadian executives in charge of industrial operations, and some notable examples of its successful application will occur to our readers.

The letter proceeds as follows:—

"At every mining centre, both great and small, there are always a number of families who have met with sufficient success to enable them to send their sons to college to receive a professional training. After obtaining their degree, the old folks, hoping to have them near home, encourage a search for success in their home town, the place of their birth — hence very dear to their hearts. However, disappointment ensues. They find it almost impossible to obtain an opening at all worthy of their ability. By this I do not mean to imply that the mining settlements are devoid of responsible positions. Not so—there are many, the majority being held by technical men whom the operators have secured from afar, thus rendering it difficult for the native young men to return home with an expectation of progress or success at home.

Now why would it not be an honorable, as well as a just. scheme for the operators to keep a record of all the young men of their particular district, and materially aid in assisting those who have received their degrees and wish to return, by favoring them, in place of sending away for their technical trained men? Right here, we shall all agree that charity always begins at home, but whereas to some this might appear as such, I venture to state that it should simply be nothing more or less than a pledged duty on the part of the operators, as the parents, residents of the place for years, have spent both their time and money, through hardships and otherwise, in the upbuilding, as well as the uplifting of the mining community. So why should they not receive, at least, the small recompense of seeing their sons occupying the important positions at the mines and mills, thereby carrying on the good work in, possibly, a higher degree.

Then, too, it would be sensible to assume that these young men would prove of greater value to the mining companies than men from the outside, as naturally the entire interest of the company, as well as the district at large, is close to their heart, whereas, with the nonresident, it would be more likely to be simply a money proposition, and he would not seem so inclined to keep the "home fire burning," so to speak, or further the interests of the company or district. On the other hand, the native son, possessing a natural interest in the home district, would have at heart the best interest of the population, and where the people of a district are met with a sincere spirit they are pretty sure to practice a little reciprocity themselves, in return. So in this manner the native son would prove another ace, because he would help to promote a closer co-operation between the workmen and the managers, which is as essential to successful operation of mining companies as well as of other enterprises; so I think these suggestions might prove worthy of careful consideration, and if the fundamental values of the matter could be more clearly conceived and more directly pursued, it would drive home an affirmative conclusion with telling power."

Annual Meeting, American Iron and Steel Institute, May 1919

By Dr. ALFRED STANSFIELD.

The fifteenth general meeting of the American Iron and Steel Institute was held in the Hotel Pennsylvania, New York, on Friday, May 23rd. There was so large an attendance that the accommodation of New York's largest hotel was taxed to the limits. The room of meeting was so crowded that many were unable to gain entrance to hear the presidential address by Judge Gary, and in the evening about thirteen hundred members and guests sat down to the banquet.

The speeches delivered at the meeting referred in the first place to the recent war. It was pointed out that the war was one of steel, and the overwhelming importance of the iron and steel industry in this connection was fully emphasized. At the beginning of the war the Central Empires had collected large stocks of iron and steel, they had also very large producing capacities, and in addition to this, they seized, in the early months of the war, some nine-tenths of the producing plants of France and Belgium. Under these conditions they had a large preponderance of steel supplies as compared with the European countries with whom they were at war, and if it had not been for the supply from this continent, it seems probable that Germany would have won the war.

Taking the moral to ourselves, we in Canada have felt thankful for our own iron and steel industry, which was built up through long years of discouragement and with necessary aid from the Government. This industry stood the Allies in good stead during the war, and we must not forget the lesson, but must do whatever is practicable to maintain an industry that is fundamental to the industrial life of a large country like ours. It is fortunate that different points of view are held by those engaged in manufacture and those engaged in the cultivation of the soil. Both of these are essential industries, and the Government must see to it that neither is sacrificed to the other.

It is impossible that we in Canada can have in the near future a gathering of iron and steel men that will compare in any way with that recently held in New York, but we may hope that the Iron and Steel Section of the Canadian Mining Institute, with the assistance of its new Secretary, Mr. F. W. Gray, will soon become an important element in our industrial progress.

The presidential address by Judge Gary was directed to considerations of the war and the future developments of the iron and steel industry. He pointed out that the members of the Iron and Steel Association had been largely responsible for the production of steel which had enabled the Allies to win the war. He referred to their negotiations with Government officials in regard to prices and other sides of production, and admitted that the officials, although exacting in their requirements, had been found to be just, and that all the steel makers had ultimately realized this. The war had been a war of steel. Steel makers had made good and had saved civilization, and now they must turn their energies to the conduct of business in times of peace. The outlook for business was good; a large wheat crop had been promised; the transportation of this crop would give money to the railroad companies, and they in turn would possibly think of improving their rolling stock and road bed, and thus some orders might come to the steel makers.

The Judge referred to the terms of peace with Germany. He pointed out that our passions had necessarily been inflamed by the wanton and barbarous conduct of the Germans, and he admitted that those living nearer the war must feel these horrors far more deeply than Americans. He pointed out that in spite of this it must be remembered that the peace was for the future, that any peace to be permanent must be just, and that the peace terms could only be satisfactory in so far as they were just.

The President referred to the competition in the steel industry which would take place under peace conditions, and appeared to suggest that Americans would combine together to enable them to meet the competition of other nations. Unlimited competition was a thing of the past. In the future business could only proceed by co-operation. He spoke of their relations with the German steel makers. These had been satisfactory in the past, and they would be renewed in the future. The Americans would deal honestly with the Germans, and would require the Germans to deal honestly with them. The future of industry depends largely on labor conditions. In the trenches men of all classes in society have worked together with perfect equality, and good will, and in the future this condition should be aimed at in industry. Co-operation among classes as well as among nations is essential for the well being of all.

Before the war, the European nations considered that Americans were actuated solely by the desire for the dollar. The behaviour of the American steel makers had shown this to be incorrect. When war was declared, they agreed to price regulation by the Government whereby the Government had saved \$15,-000,000, and they had gone so far as to supply steel on equal terms to the Governments of the Allies.

Director S. W. Stratton, of the Bureau of Standards, Washington, gave a very interesting account of the Bureau and of its activities in helping industry. He pointed out, in the first place, that Government methods had improved in recent years. At one time government signified restrictions only, but now it was directed largely to helping the industries of all sections of the nation. In the past it was paternal, and it is fast becoming fraternal. He asked the Institute to appoint a Committee to investigate the action of the Bureau and to see that it applied itself to problems affecting the steel industry. The Bureau was related directly with the industries for the purpose of heping them. The work of the Bureau was essentially the construction and maintenance of standards. These were not merely standards of length and weight, but standards of all kinds—electrical, optical, etc., and standards of materials. The Bureau, in the first place, was intended to assist the Government in the purchase of materials; but this is now but a small part of its activities, which are directed mainly to helping the industries.

In selecting work for the Bureau, it was recognized that this must necessarily be limited to fundamental problems, and that the smaller or secondary prob-

lems should be dealt with by the industries directly concerned. In one of their large buildings at Washington the two lower floors were devoted entirely to metallurgical appliances. These laboratories contained steel rolling mills, presses and all kinds of apparatus for testing metallurgical materials. Mr. Stratton gave an interesting account, illustrated with lantern slides, of a number of the activities of the Bureau. Sets of weights have been carefully built up and used for standardizing purposes. The difficulty of weighing to the necessary degree of accuracy is very great, and for this purpose, balances of unusual precision are placed in a closed room which can be kept at a constant temperature, and which is not entered by the observer, who operates the balances by long handles from the outside. In making accurate determinations, the air is removed from the balance case, so that the weighing is done substantially in a vacuum. For the purpose of testing weights and weighing machines in use all over the country, a testing car has been provided which can be sent wherever it is needed, and this has led to a great increase in the accuracy of these machines. The original standard of length was a "line standard," being the length between two marks on the standard meter. For engineering purposes "end standards" must be used and these have been constructed by the Bureau and used for the preparation of all kinds of measures. Electrical standards were also referred to, such as the standard on which is used in all electrical measurements. Very delicate appliances have been devised for the measurement of radiant heat. These appliances could measure the heat given out by a candle at a very great distance, and are employed for a number of engineering problems. Appliances for measuring the expansion of substances by heat have very important applications. In particular it is found that some structures have torn themselves to pieces because the elements of their construction had different rates of expansion. The measurement of quantities of heat, or calorimetry, is essential in the testing of engines, and even in so ordinary a matter as the designing of radiators. A special variety of photographic plate has been devised, which is particularly sensitive to red rays. The need for this came from the aviators who found that photographs on ordinary plates could not be taken when there was even a moderate amount of fog or mist, as this stopped the actinic rays which are made use of in most photography. The red sensitive plates were found very useful by the aviators, and now that the war is over, they will soon be placed on the market for ordinary use, as they will give better color values in photography. A very interesting apparatus was devised for locating a battery by sound. This consisted of a system of recording chronographs which measured the exact moment at which the sound of a gun arrived at different stations. By combining these records, it was possible to deduce exactly the location of the enemy gun and the Allied guns could then be trained on this point, even if it were invisible. The accuracy was so great that one shot in three would usually hit the target.

The laboratories contained enormous mechanical testing machines. One of these was shown testing three-inch steel-wire hawsers. Still another was depicted in the act of testing a column of masonry or brick work. Before the war the finest qualities of optical glass and many optical instruments were made in Germany. The Bureau has worked effectively in this direction, and can now show American glassmakers how to produce any required variety of glass. Special refractory crucibles were needed for melting glass, and in the past these were both costly and bad. The Bureau had devised methods of making these crucibles far more cheaply and quickly than before, and of better quality.

Mr. Stratton strongly recommended the use in such laboratories of small unit plants for testing all kinds of processes and materials. They have, for example, a small kiln for burning and testing refractories and bricks, a small cement mill for solving problems with regard to cement, a paper mill producing a roll of paper thirty inches wide, a rubber mill, a sixteen inch rolling mill and a small press, so that all kinds of steel made in the laboratories of the Bureau can be rolled or pressed and tested practically. Mr. Stratton stated that, in the past, many specifications had been based largely on tradition, but that with the aid of information such as is being obtained by the Bureau, it is now possible to improve these specifications so that they would be based on truth rather than on tradition.

In view of the wonderful developments, and uses of the United States Bureau of Standards, it is pertinent to speak of conditions in this country. Canadian manufacturers who have problems to solve are frequently obliged to send them to the Bureau at Washington because there is no Canadian laboratory that is entirely capable of handling them. This is no criticism of some Government Department or of the Canadian Universities, which have done important work in the past, and particularly during the war, in solving many problems that have presented themselves to Canadian manufacturers. The Universities are limited in the scale of their operations, and we must be glad that there is a prospect of the institution of a Canadian Research Institute in the near future. This Institute, which is to be founded under the auspices of the Advisory Research Council, will be directed, like the Bureau at Washington, to the solution of those large problems that cannot well be undertaken by the individual industries and which are beyond the scope of the Universities. It is not intended that this Institute shall take away the research work that is now effectively done by the Universities, and indeed it will be necessary to encourage such work so that students after graduation in the Universities, shall be able to spend a few years in learning research methods in the university laboratories, after which they will be qualified to carry on research effectively in the Research Institute, or in the laboratories of the larger industrial establishments. The need for men qualified in research has been recognized of late, and steps must be taken to train such men in the near future.

A paper was read by Mr. T. F. Baily, President of the Electric Furnace Company at Alliance, Ohio. Mr Baily represents a recent development of the electric furnace which may not be familiar to all of our readers. Everyone knows something about the electric steel-melting furnace in which steel is melted by means of powerful electric arcs, but the newer development, the use of electric heating for annealing and similar purposes, is not so widely known. The electric furnaces devised by Mr. Baily are now in use for an-

nealing many articles of cast steel, for heat-treating and tempering chains and similar products, and even for heating ingots before rolling, in place of the ordinary gas-fired soaking pit. Furnaces for these purposes must be heated steadily to a very uniform temperature, and for this purpose the electric arc is not at all suitable. The heating element consists instead of large troughs made of carborundum, and containing broken carbon through which the electric current is passed. Such a furnace resembles, on a very large scale, the ordinary wire-wound electric furnace of the laboratory. These furnaces are effective in maintaining a uniform and constant temperature for operations where the accuracy of temperature control is important. The cost of heating in electrical furnaces is necessarily higher than in gas-fired furnaces, but the greater accuracy of control has been found to reduce very much the percentage of rejected products, and the cost per ton of accepted material is usually less than with the old fashioned appliances. One particular advantage of the electric furnace is the much smaller amount of scaling and loss by oxidation, which in the case of high priced steel represents a very material saving. (Mr. Baily's paper on "Electrically Heated Soaking Pits" will appear in our next issue.)

An important paper on "Sonims" was read by Mr. Henry D. Hibbard. "Sonims" is a word invented by Mr. Hibbard to denote "solid non-metallic impurities" in steel, that is to say, such impurities as particles of slag, oxides, sulphides, particles of sand and brick, etc., which are originally included in the steel or become mixed with it mechanically during the operation of pouring. It has long been recognized that the chemical analysis of steel, representing as it usually does the metallic and chemical elements in the steel itself, does not completely represent the whole contents of the steel, and does not give a complete indication of the quality of the steel. It is recognized that these non-metallic impurities such as particles of slag and pieces of brick or sand from the moulds interfere with the mechanical properties of the steel to at least as great an extent as do the small amounts of phosphorus and sulphur on which the chemists have necessarily laid stress in the past. In view of the great reduction in elongation which is produced by a small notch in a bar, it is obvious that small particles contained in the steel will be certain to reduce elongation, even if they do not greatly reduce the ultimate strength of a piece of steel. In general, the remedy for this state of things is to hold the steel in the ladle for a considerable time after the addition of the deoxidizer, so that the slag and oxides can have time to float to the surface and separate themselves from the steel. Even this does not, however, remove the danger of bits of brick and sand from the moulds, and these are particularly apt to be included during the bottom-casting of ingots. The war, with its more rigid specifications for steel and other materials, has directed attention to the necessity of maintaining a higher standard than in the past, and this, in the case of steel, can only be attained by constant care throughout every stage of the process of its manufacture.

A paper on the "By-product Coke Plant at Clairton, Pa.," was presented by the Superintendent, Mr. Frank J. Marquard. In this paper is shown the latest development in by-product coke making. I may mention here that the production of by-product coke has made great advances in recent years. In the past the majority of coke in the United States was made by the old fashioned and wasteful beehive oven, but this condition is passing away and the present year, for the first time in the history of American industry, should see the majority of coke made in the by-product oven. In this connection we should remember that in Canada we must continually look in the direction of improvements in the technique and economy of our metallurgical processes. In the past, with abundant natural resources, the idea was merely to get a product as quickly as possible regardless of waste, but we now realize that the prodigal use of our resources cannot continue indefinitely, and that increasing care must be expended in obtaining the maximum of efficiency and economy in the use of those resources which, when once spent, can never be recalled.

The paper by Mr. F. T. Llewellyn on "The Standardizing of Shipbuilding Materials" will be interesting to Canadians in view of our increasing shipbuilding industry. When developing shipbuilding in the United States to combat the submarine warfare of the Germans, many practical difficulties were met in conducting this on a large scale, and in an effective manner. Difficulty was experienced in regard to the use of terms as it was found that the marine engineers not only used terms that were unknown to the land engineers, but that they often used the same terms with a different meaning; and this led to serious difficulties when employing land engineers for shipbuilding and designing. Another difficulty was found in the very large number of sections that were in use in shipbuilding. Each firm apparently designed ships without any reference to the practice of other firms, and in this way hundreds of different shapes and sizes of steel were necessary for the construction of a single ship. After a number of conferences on the subject, it was found possible to effect a compromise whereby the number of materials essential for the construction of a ship, was very materially reduced and the designers employed by the different firms agreed to modify their methods so as to use the standard ship materials which had been decided upon.

A paper by Mr. Jacob A. Mohr, on "The Methods of Charging Raw Materials into the Blast Furnace" shows that even in this department, there is a possibility of improved methods. The paper discusses the supply of everything entering the blast furnace, namely, air, iron ores, coke or other fuel and flux. Attention was mainly directed to the order and amounts in which the ore, coke and limestone were charged in at the top of the furnace. In particular, it was found that for furnaces using the Mesabi ores, better results were obtained if the ore and other materials were charged in smaller quantities, so that they become more intimately mixed in the furnace. In the past it was supposed that the best economy was obtained by charging the coke in large units so as to avoid any mixture of the coke and core. With the more powdery ores at present in use, this is not found to hold, perhaps because it is necessary that the coke should mix with the ore for the purpose of making the latter more open in structure for the passage of the blast. Another point of interest was that no system of charging ore, coke and flux was found to work with entire satisfaction as a permanent arrangement, but that after a time the furnace would become less efficient and that then a change in the order of charging would frequently bring about a decided improvement.

Static, Dynamic, and Notch Toughness

By SAMUEL L. HOYT, E.M., Ph.D.,[1]

Some of the more important properties of finished materials are strength, ductility, toughness, resistance to alternating and repeated stresses, etc. Of these, the property that appears to have received the least consideration, at least in this country, is toughness, which is due, possibly, to our regarding toughness as a qualitative property or, at any rate, as one that parallels ductility. This arises out of our greater experience with the simple carbon steels in the rolled or forged (non-heat-treated) condition which, qualitatively, are tough if ductile and are not tough if brittle. In this way we have erroneously become accustomed to judging the toughness of a material from its behavior in the tensile or similar test.

The point of view presented in the present paper is that toughness, like hardness or tensile strength, should be regarded as an independent property and of sufficient importance to require, in so far as that may be possible, quantitative determinations. If such be true, it becomes at once necessary to devise experimental means for measuring or valuating toughness, and the notched-bar impact test (the Charpy test) is advanced as the most logical test that has so far been developed for this purpose. It is further advanced, with particular emphasis, that we have two kinds of toughness to deal with and, accordingly, they will be dealt with independently.

Classification of Materials According to Toughness.

Toughness has been defined somewhat as follows: Tough materials are those that offer considerable resistance to permanent deformation but which, once such resistance has been overcome, may be deformed plastically, but only by the expenditure of considerable energy. In other words, tough materials may be deformed plastically but they absorb a considerable amount of work in the process. This kind of toughness may be called "static" toughness when the rate of loading is reasonably slow or "dynamic" toughness when the rate of loading is comparatively rapid, as in impact testing, but in all cases the strain distribution is essentially uniform. However, static toughness does not imply resistance to shock, or dynamic toughness. In fact, dynamic toughness may be equal to, greater than, or less than the static toughness, thus dividing materials into three classes. This is well shown by numerous cases on record.

Tests on the resistance to impact of cast-iron bars, as made by Russell,[2] indicate that cast iron is nearly one-half again as resistant under impact as it is under static loading, using for the comparison the amounts of work absorbed in producing fracture. Considere,[3] working on the dynamic resistance of soft-iron wire, showed that to produce a given deformation greater loads were required if suddenly applied than if slowly applied, but that the total deformation (ductility) remained constant. According to this, soft iron absorbs more work when broken by dynamic loading than by static loading.[4] One of the most notable cases of this kind is that described by De Freminville[5] in discussing the application of impact testing to the selection of metals for use in machine construction. De Freminville considered two types of parts according to their behavior under impact, both of which must be made of materials that are highly resistant and able to absorb heavy impacts. The first type must do so and yet not deform appreciably, while the second type is allowed considerable deformation provided the part so stressed is able to retain its original shape when the load is released. During the course of this work, one steel was found that was considerably more resistant under impact than under static loading, and so, for his purpose, was particularly valuable. The ordinary (static) tests failed to bring out the superior quality of this steel. The class of materials that has practically the same behavior under static and dynamic loading is fairly large, as has been shown by the work of Breuil,[6] Hatt,[7] Fremont,[8] Charpy[9], and Martens.[10]

Tests on the third class of materials, which possess remarkably low resistance to impact, were carried out by Considere[11] who brought out some very interesting point in connection with the dynamic properties of metals. The resistance to impact of soft-iron wire under shear and under tension was measured with varying velocities of impact by gradually increasing the height of drop of the weight producing the impact. It was found that the resistance to impact increased directly with the velocity of the impact up to and even beyond that velocity which was sufficient to cause the rupture at one blow. By still further increasing the height of drop, a velocity was reached at which the material broke suddenly with very low impact resistance and with negligible deformation. At velocities above this critical velocity, the resistance to impact is obviously much inferior to the static strength. By increasing the weight to a certain (critical) amount the resistance to impact decreased sharply as soon as the velocity was sufficient to cause the rupture with

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* Reprinted from the Trans. of the American Institute of Mining Engineers. New York Meeting, Feby., 1919.

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[1]Associate Professor of Metallography, University of Minnesota.

[2]S. Bent. Russell: Experiments with a New Machine for Testing Materials by Impact. Trans. Amer. Soc. Civil Engineers (1898) **39**, 237.

[3]Contrib. a l'etude de la Fragilite dans les Fers et les Aciers, p. 3.

[4]This, of course, does not mean that the material can stand repeated loads greater than the known tensile strength even though they be applied suddenly.

[5]Contrib. a l'etude de la Fragilite dans les Fers et les Aciers, p. 475.

[6]Pierre Breuil: Abstract of paper on effects of stresses. Jnl. Iron & Steel Inst. (1904, No. 1) **65**, 413.

[7]W. Kendrick Hatt: Tensile Impact Tests of Metals. Proc. Amer. Soc. Test. Mat. (1904) **4**, 282.

[8]Contrib. a l'etude de la Fragilite dans les Fers et les Aciers, p. 150.

[9]Ibid., p. 213.

[10]Adolf Martens: Handbook of Testing Materials, translation by G. C. Henning, 233. John Wiley & Sons, New York, 1899.

one blow.[12] In such a case, heavy impacts are much more dangerous than light impacts even though the amount of energy expanded is the same in both cases. Temperatures from—10° to 150° C. were found to have only a minor (primary) influence, but a very important secondary temperature influence was found, inasmuch as low temperatures caused a marked lowering of the critical velocity. These tests served also to bring out the inferiority, under impact, of hard-drawn iron wire as compared to annealed wire. Under static loading, the tensile strength of the unannealed wire was greater than that of the annealed wire, but under impact both the deformation and the tensile strength were less for the unannealed wire, which shows that in certain cases a high static tensile strength is not a sufficient guarantee of strength.

Notch Toughness.

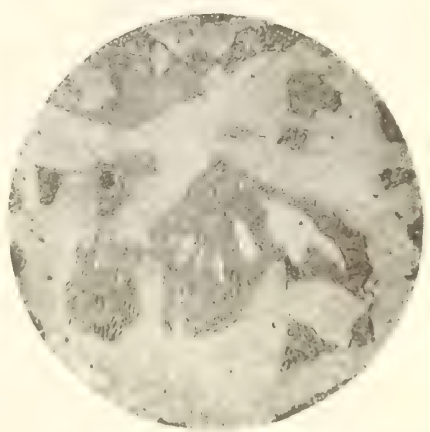
It is well known that a stress applied to a bar that has a sudden change in cross-section along its length produces a decidedly non-uniform strain distribution at change in cross-section. If the change in cross-section is in the form of a nick or a groove, the strains at the base of the nick multiply and are much greater than the average strain over the cross-section. Such a nick, or sudden change in cross-section, is here referred to as a "notch," and the non-uniform strain distribution, as the "notch effect." The ability of a material to withstand streses when in the notched condition is referred to as its "notch toughness."

The notch effect is well illustrated every time a blacksmith nicks a bar to break it off at any particular point. Even a blow by the hand produces strains at the base of the notch well in excess of the resistance of the material and hence produces the fracture. A similar blow on an unnotched bar would merely bend the bar over. Thus it is that a bar, even though made of normally tough material, if notched, may behave as if brittle. Koenigsberger[13] has shown by means of glass models that notches localize the stresses and that the neutral axis of a stressed bar runs close to the peak of the notch instead of remaining in the middle section. Heyn[14] has shown that a lead bar cut with a notch has an entirely different strain distribution under bending from that of a similar bar without a notch. The volumes of the strained parts were as 1:3.76 and the maximum fibre elongations, measured by the distortion of 5-mm. squares, were 120 per cent. and 70 per cent. for the notched and unnotched bars respectively. But to get a correct idea of the maximum deformation, the extension of the width of a line at the apex of the notch was determined. The original width of the line was 0.25 mm. but after deformation it was found to be 5 mm., which gave a deformation of 1700 per cent. It has also been shown by Lean,[15] that a transverse notch cut in a tensile test bar produces an uneven distribution of strains over the cross-section at the base of the notch, the greatest strain coming at the apex of the notch. These cases illustrate the notch effect as it occurs in ordinary metals, which is to localize the strains in the neighborhood of the apex of the notch, at times to such an extent that they may be far in excess of the resistance of the material under tension. In excessively brittle materials, the multiplication of the maximum fibre stress is even more excessive. An example of a notch in such materials is the small file scratch made on a glass rod to assist in breaking off any particular length.

It is likewise known that the severity of the notch effect increases as the angle of the notch decreases. On this account the notch effect increases in most materials when fracture starts, because the angle of the fracture is generally less than the angle of the original notch. Certain pliable materials, or those that are "self healing," of which lead is an example, behave in the opposite manner, since the notch becomes more rounded with distortion. In the same way a material of high notch toughness is much less dangerously affected by a notch than one with low notch toughness, a point that will receive consideration further on.

Notch Effect in Engineering Practice.

The prevalence of the notch effect in engineering practice has been brought rather forcibly to the writer's attention by investigations of failed parts that have been carried on from time to time. It was noted that the notch effect may at times be intentionally introduced by the design of the part (sometimes faulty) and at other times may be unintentionally introduced by faulty or careless workmanship; of these, the latter is the more reprehensible and the more difficult to guard against. Another equally important point is the



Figs. 1 and 2.—**Original Structure of Splice Bar.**

[11]Loc. cit.

[12]The work of Considere suggests the advisability of considering all impact testing (weight and velocity of impact) from the point of view of the critical velocity and critical weight here described.

[13]Pros. 4th Congress Intern. Assoc. for Testing Materials, Brussels, 1906, Paper C 4 d.

[14]Martens-Heyn: "Handbuch der Materialienkunde." II A, 374. Berlin, 1912. Julius Springer.

[15]Oester. Wochenschrift f. d. oeffentlichen Baudienst. (1908) **29,** 43.

necessity of considering the micro-structure and the desirability of heat treatment as a means of overcoming or counteracting the effect of the notch.

A certain railway company was having trouble with splice bar failures, which from the records it was impossible to connect with roadbed conditions. Tests on parts of the failed bars showed that the material was well up to the quality required by the specifications, so that no basis for criticism could be made on that score. It contained 0.34 per cent. carbon and 0.018 per cent. phosphorus; it had an elongation of 35 per cent. on 2 in. (50.8 mm.); a tensile strength of 65,200 lb. (29,574 kg.); and a yield point of 33,000 lb. (14,968 kg.) On making a microscopic examination, the steel showed considerable free ferrite, in characteristic Widmannstattian structure, as may be seen from Figs. 1 and 2. Furthermore, the pearlite was of the familiar lamellar type that is characteristic of slowly cooled

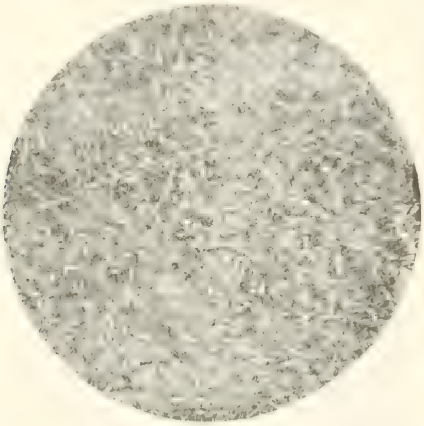


Fig. 3. × 65.

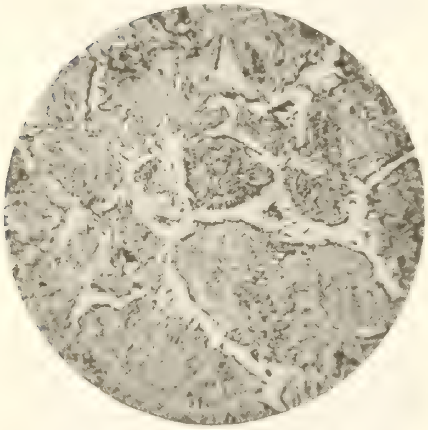


Fig. 4. Same as Fig. 3. × 565.

Structure of Splice Bar After Heat Treatment.

steels. The idea developed from this examination was that the two rails and the splice bars form a notch and that the structure of the bar was such that it could not always adequately resist the notch effect produced every time a car passed over the rail joint (repeated stresses). The solution of this problem obviously lay in correcting or improving the structure of the splice bar, to which end a series of heat-treatment tests was conducted. By subjecting the bar to a temperature of 900° C. for ½ hr. and quenching in oil, a structure was secured that was principally sorbite with only a small amount of free ferrite. The tensile strength was increased to 92,000 lb. (41,730 kg.) and the yield point to 45,000 lb. (20,411 kg.), but the elongation was decreased 22.5 per cent. A characteristic structure is reproduced in Fig. 3 and 4, which represent a small piece of a failed splice bar heat-treated in the laboratory. The original coarse Widmannstattian structure is replaced by a network structure, the major part of which is sorbite, a constituent composed of the original pearlite and most of the original ferrite. Compared to the Widmannstattian structure, sorbite may be said to be highly resistant to the notch effect. By the adoption of heat-treated splice bars the difficulty was eliminated.

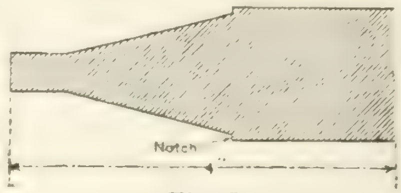


Fig. 5.

Some truck forgings, solid rear axles and steering arms, failed while in heavy service. These parts were made by a well-known automobile axle manufacturing company and suspicion rested at first upon the truck drivers, particularly as the material was known to pass all specifications. It contained 0.485 per cent. carbon; had an elongation of 27.1 per cent. in 3½in., a reduction in area of 45.6 per cent., a tensile strength of 77,500 lb. (35,153 kg.), and a yield point of 39,900 lb. (17,690 kg.). An examination of the axle (not heat-treated) showed that the taper had been cut by a roughing tool in such a way as to leave the notch indicated in Fig. 5. Knowing the danger of the presence of such a notch if the steel were in a poor physical condition, a microscopical examination was made; this showed the condition represented in Figs. 6 and 7.

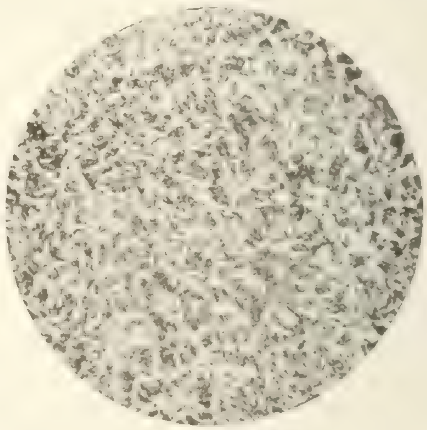


Fig. 6. × 65.

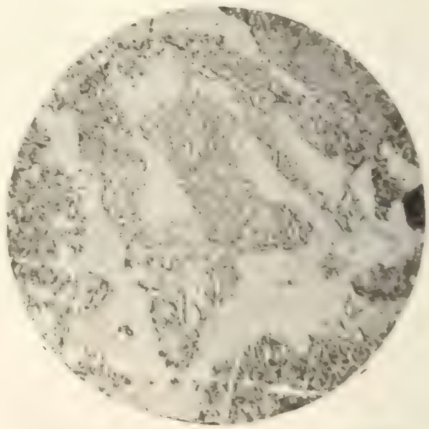


Fig. 7.—Same as Fig. 6. ×565.

Original Structure of Rear Axle.

Here again the presence of a relatively large amount of excess ferrite will be noted. The result of a simple oil quench of a part of the failed axle is shown by Fig. 8. While the free ferrite has been largely eliminated and sorbite has been substituted for pearlite, an even better heat treatment would be to quench the axle in

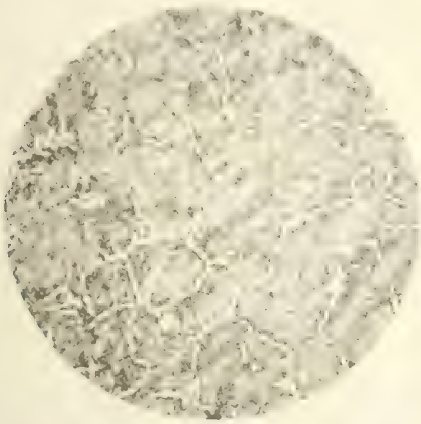


Fig. 8.—**Structure of Axle When Oil Quenched.** ×130.

water, to entirely prevent the segregation of ferrite, and to reheat to produce sorbite and the requisite mechanical properties.

The danger of a keyseat in an axle is well illustrated by Figs. 9 and 10, which show the extensions of two cracks leading from the angles of the keyseat. If good engineering practice calls for such a keyseat, the material should be suitably heat-treated to give it a high notch toughness; or better yet, the material itself, as well as the heat treatment, should be selected with reference to its notch toughness.

An examination of the truck steering arms (which were heat-treated) also revealed the presence of a notch due to defective design or construction of the drop-forging die. Microscopic examination of the failed steering arms showed the heat treatment to have been imperfect inasmuch as granular pearlite, instead of sorbite was formed which, while ductile and strong, is not at all a satisfactory structure in the presence of a notch. A similar examination of satisfactory steering arms showed sorbite.

Tests for Toughness.

It has been customary to test materials by various static and dynamic tests and to judge from the strength and ductility whether the quality of the material is sufficiently high to warrant its use regardless of the design of the part, its relationship to other parts, or

Fig. 9. **Left Side of Keyseat.** ×16.

Fig. 10.—**Right Side of Keyseat.** ×16.

possible defects due to faulty workmanship. One of the objects of the present paper is to show that, in case the material is to be used in the notched condition, the usual tests are unable to differentiate clearly between materials that will probably stand up and those that are likely to fail. This means that it is necessary to supplement the ordinary tests with a test on notched bars.

In order properly to define what is meant by toughness, it was necessary to distinguish between conditions of uniform and of non-uniform strain distribution. Likewise in testing the toughness of materials the same distinction must be made, a point that, due to its more or less general disregard, is somewhat strongly emphasized here. A qualitative test for toughness quite commonly used is the nick and fracture test for fibre. This test is useful to a certain extent but it should have no more place in scientific testing of materials than an ordinary scratch test for hardness. The reduction of area in the tensile tests is very frequently looked at with an idea of sizing up the toughness only in a limited sense, inasmuch as it is the ability to deform and not the resistance to such deformation that is determined. The area of the stress-stain diagram may be taken as a measure of the static toughness. Such measurements show, for example, that the toughness of annealed carbon steel increases with the carbon content up to about 0.3 per cent C. This figure, combined possibly with the resistance to impact, should be very useful in case the strain distribution of the finished part is essentially uniform. The value obtained by dividing the tensile strength by the proportional limit and multiplying by the elongation (Martens) may be very useful in certain cases; for example, in bringing out the toughness of pure copper. The value of this determination is also limited, as it does not include the resistance with which a material opposes permanent deformation. All of these values are of undoubted importance when properly interpreted, but none would bring out the weakness of the materials in the foregoing examples. In fact, due to their apparent indication of strength and resistance, they would be directly misleading.

The recognition of the peculiar weakness of certain materials when in the notched condition has led to the development of the impact test on notched bars as a supplement to the customary static and dynamic tests and for the express purpose of testing materials for toughness. In its present form, the test is the result of systematic experiments extending over two decades or more by Barba, Fremont, Charpy, Ast, and others.

which culminated in the reports of Charpy to the International Association for Testing Materials in 1909 and 1916[16] and of Ehrensberger to the German Society for Testing Materials in 1909.[17] The accumulation of evidence over this period made possible the establishment of a standard test so that now it can be safely stated that the notched-bar test, or in particular the Charpy test, is capable of supplying information relative to toughness that the tensile test gives in but an imperfect, and often in a directly misleading, manner. The test shows the great danger of angular notches or sudden changes in cross-section, particularly when material of low notch toughness is used.

In the report of Ehrensberger, results of tests on three classes of materials were given: forged carbon steels, forged special steels, and cast carbon steels. These three classes of materials can be compared by means of the figures shown in Table 1, which are taken from the report.

TABLE 1

Test No.	Tensile Strength, Pounds per Square Inch	Yield Point, Pounds per Square Inch	Elongation,* Per Cent	Reduction in Area, Per Cent	Notched [illegible] Metric Tons [illegible]	Remarks
	[illegible]					
1	61,500	32,700	26.5	64	4.6	Forged too hot.
2	64,100	36,100	26.0	70	20.4	Correctly forged
9	71,600	42,000	24.5	70	22.6	
10	71,800	40,000	26.4	60	4.7	Failed railway axle.
25	142,200	93,000	12.1	36	8.5	High carbon.
	Forged N[illegible] Steels					
51	72,800	58,200	23.3	70	42.1	
69	130,000	108,600	15.1	62	22.1	
71	142,200	118,200	13.3	56	19.3	
75	270,200	232,500	6.5	31	8.3	
	Cast Steel					
161	68,000	37,700	22.9	51	3.7	

* [illegible] length equal to 10 times the diameter

Table I.

A few comparisons may serve to bring out the value of the Charpy test for toughness. Tests 1 and 2 show that the notched-bar test bring out the lack of toughness (or at least notch toughness) of test bar 1, which was forged too hot, although no evidence of this was given by the tensile test. Tests 1 and 25 show very plainly that the toughness cannot be entirely judged from the reduction of area or elongation; test bar 1 is more ductile of the two but test bar 25 possesses the greater notch toughness. Test 10 shows how far the tensile properties can come from indicating lack of toughness as the probable cause of failure, although the true character of the material is brought out by the notched-bar test. A comparison of the carbon steels with the special steels reveals a superiority for the latter that is not as clearly brought out by the tensile tests. The tensile tests indicate that the special steels have greater tensile strength for the same ductility, but the superior toughness of the latter is better brought out by the notched-bar test. The tensile properties of the cast-steel specimens show that cast steel may have excellent elongation and reduction of area, and be thus apparently ductile, but be quite lacking in resistance when tested in the notched condition. Thus cast steel behaves the same as a piece of overheated steel.

In Charpy's report of 1909, an interesting case was cited to show that the notched-bar test can give information regarding steel that is in no wise suggested by the tensile tests, either static or dynamic. The results obtained with two steels A and B, really the same

TABLE 2.

Steel	Elastic Limit, Pounds per Square Inch	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent	Reduction of Area, Per Cent	[illegible] Resistance Kilograms	Tensile Impact Resistance Kilograms	Charpy Test, Kilograms
A	42,800	59,900	32.0	67.2	179.5	205	44.0
B	42,700	62,700	32.0	65.6	185.0	195	2.7

Table 2.

steel in two different conditions of heat treatment, are given in Table 2. Not even the resistance to fracture produced by a weight falling from a height of about 100 ft. (30 m.) as given in the next to the last column, indicates the excessive brittleness of steel B. The microstructure at once showed that B is in a much poorer condition than A.

These figures could be multiplied almost indefinitely and have been well known for over a decade. There can now no longer be any doubt that there is some property, which is of great technical importance, that is not measured and in many cases not even indicated by the usual tensile test. In spite of this undoubted fact, the Charpy test, which is now extensively used in Europe, is given but little attention in this country. This would seem to be due to lack of familiarity on the part of users of steel with the facts that in a very large number of cases materials are used in a notched condition, whether intentionally or otherwise, and that when so used the tensile test offers no reliable index of their probable behavior. If these points were considered, the purchaser would certainly insist that his materials show a high degree of notch toughness in all cases where they are to be used in the notched condition.

Various objections have been raised to the adoption of the notched-bar test, one of the principal ones being the so-called lack of uniformity of the results. This question has been gone into rather thoroughly by Prof. Howe, [18] and more recently by Charpy and Cornu-Thenard.[19] In a number of cases the results of the notched-bar impact test are not as concordant as might be desired. It is the opinion of many experimenters, however, that variations in the impact resistance of supposedly similar test bars are due to actual variations in the material, the wide scale of the Charpy test throwthem into greater prominence than do the usual tests. The truth of this contention is demonstrated by the recent work of Charpy and Cornu-Thenard, who, by using exceptionally uniform and homogeneous bars, secured check results as close as 1 to 2 per cent. and scarcely every varying as much as 4 per cent.[20] The results obtained by the commission of the German

[16]G. Charpy: Report on Impact Tests of Metals. Proc. Int. Assn. for Test. Mat. (May, 1908-Feb., 1910) **1**, No. 5, III$_1$; Report of Impact Tests and the Work of Committee No. 26 (May, 1910-May, 1913) **2**, Pt. 2, IV$_1$.

[17]Ehrensberger: Stahl u. Eisen (1909) **28**, 1737.

[18]Trans. (1913) **47, 501**.

[19]G. Charpy and A. Cornu-Thenard: Rev. de Met. (1917) **14**, 84; Jnl. Iron & Steel Inst. (1917, No. 2) **61**.

society were sufficiently concordant to lead to the adoption of the test and the minor variations were not permitted to mask the fact that the notched-bar test is capable of yielding valuable information that the tensile test does not.

The writer is informed that at least one steel plant, which has done considerable work on the notched-bar test including the Charpy test, has found the concordance of results to be very satisfactory and capable of yielding possible differences of impact resistance of the order of magnitude of 1:30. Thus, it would seem that lack of concordance can now no longer be advanced as an objection to the adoption of the Charpy test.

There has also been considerable objection to the presence of the notch in the test bar, the idea being that the nick localizes the breaking point and so does not test the weakest cross-section.[21] This is undoubtedly a point that must be considered when using the Charpy test. For example, if there is excessive segregation it is quite possible that the base of the notch will come at the weaker part and so lead to low results. At the same time such variation in results is a valuable indication of segregation, so that by breaking a number of test bars not only can the average value be obtained but non-homogeneity in the material itself can be determined. The object of the Charpy test is not so much to test any particular test bar,[22] as it is to test the relative toughness of a certain material[23] or the efficacy of a certain heat treatment. Moreover, it is quite customary, at least in certain quarters, to precede the Charpy test by macroscopic tests for gross segregations in order that variations due to such segregation may be eliminated.

Recently there has been an attempt to eliminate the notch from impact testing, in the impact shear test described by Dr. McAdam. In this test, an unnotched bar is sheared by an impact while the impact figure is read the same as in the Charpy test. It has been argued[24] that by eliminating all except one stress the impact shear test is superior to the Charpy test. There can be no doubt that the materials to be subjected to shearing stresses by impact (in an unnotched condition) might well be tested by this method; but no test on unnotched bars can be substituted for a notched-bar test. The correctness of this assertion is supported by the results of the impact shear test according to which such materials as properly heat-treated nickel and chrome-nickel steels fail to give as much resistance to impact as carbon steel or even ingot iron.

[20]Even a 4 per cent. variation could scarcely be objected to on the score of lack of concordance in the light of the present practice in pulling test bars. A 4 per cent. variation would mean a variation from 49,000 to 51,000 lb. per sq. in., a variation that is much less than variations due to improper rate of loading, improperly holding the test bar in the machine, and in particular to the general neglect of the proportional limit in favor of the yield point as a measure of the elastic limit.

[21]H. M. Howe: The Resilience Test. Met. & Chem. Eng. (1917) **17**, 298; Walter Rosenhain: "Introduction to the Study of Physical Metallurgy," 237. New York, 1915. D. Van Nostrand Co.

[22]The use of the Charpy test as an acceptance test would hardly merit discussion until the value and importance of the test proper is generally conceded.

[23]This statement is subject to the reservation advanced by Prof. Howe that, due to the greater plasticity of low-carbon steels, we canot directly compare steels of essentially different carbon contents.

Summary.

Undoubtedly the occurrence of the notch effect in machines and engineering structures is much more common than is generally recognized. This is generally due to the design of the structure, but may be caused by faulty workmanship. Even a hasty examination of such machines as locomotives, automobiles, stationary gas engines, steam engines, etc., reveals an amazingly large number of notches and in many such cases the material composing the parts should have a high degree of notch toughness to insure against failure.

The logical test for such materials and the only one capable of yielding reliable results is the notched-bar test. This test should supplement the usual tensile or hardness tests and its results used as an index of the resistance of the material to the notch effect.

A factor of safety is generally used in the design of parts of machines requiring the material to have a certain strength combined with a certain amount of ductility. These properties are written into the specifications and the material is inspected on such a basis. Neither the factor of safety nor the usual properties offer a guarantee against failure in cases similar to those discussed here. It is for this reason that the cause of many failures remains a mystery when test bars taken from the broken parts are found to pass all specifications. The Charpy test would undoubtedly show a low impact value, due either to faulty heat treatment, in case the parts were heat-treated, or to lack of proper heat treatment.

[24]Personal communication.

IMPORTANT WORK IN CONNECTION WITH HARBOR DEVELOPMENT SCHEME AT VANCOUVER.

A party from the Topographical Department of the Federal Government will shortly arrive in Vancouver. This party is in charge of Chief Topographer W. H. Boyd and his assistants, Messrs. A. C. T. Sheppard, A. G. Haultain and J. R. Cox.

This party will make a detailed topographical map of the tidal area in the Vancouver district, including Burrard Inlet, and the Fraser River, from Port Haney to the mouth.

It is figured that this is the best thing that has ever been done along these lines for this department.

The Topographical Department is working in cooperation with the Public Works Department, Interior Department, and the Hydrographic Survey.

The idea of sending this party out here was not originally in connection with the harbor development work, but to make a study of the Fraser River Delta sedimentation changes, and to work out some scheme to keep the mouth of the Fraser open. This was afterwards changed to include Burrard Inlet, and as it is now planned, when this work is completed the results will be most valuable to engineers and others interested in this tidal area.

The work will take about two years to complete.

Electric Smelting of Iron Ores in British Columbia

By ALFRED STANSFIELD

British Columbia Department of Mines, Bulletin No. 2, 1919.

Continued from May number

(Concluded.)

APPENDIX XI.

Report by Messrs. Beckman and Linden.

Introductory Note by Dr. Stansfield.

When undertaking the present investigation I considered that it was very important to decide whether the high Swedish furnace or the simpler pit furnace used at Heroult would be the more suitable under the conditions existing in British Columbia.

I was familiar with the Swedish furnaces, but not with the Californian furnace, and I therefore visited San Francisco and Heroult. At San Francisco I met Messrs. Beckman and Linden, an engineering firm who have specialized in electric smelting and had recently erected a plant for the production of ferro-alloys at Bay Point. Mr. Beckman is familiar with conditions in Sweden as well as in California, and I therefore discussed with him the design of furnace and plant for the production of pig-iron. In spite of his knowledge of the Swedish type of electric furnace, Mr. Beckman concluded that a simple pit furnace of the kind used for making ferro-alloys would, on the whole, be better than the Swedish furnace for the conditions in British Columbia. Such a furnace is substantially the same as the furnace that has been used at Heroult, with the exception of the roof and charging-chutes. In view of Mr. Beckman's knowledge of Sweden and California and of his experience in designing, erecting, and operating the plant at Bay Point, I asked him to prepare a design for an electric-smelting plant in British Columbia. The general outline of the plant was arranged between us, and I furnished him with the necessary data in regard to the nature and cost of the ore, charcoal, power and labor. I understood that he would give an estimate for the consumption of power and charcoal per ton of pig-iron, but Mr. Beckman finally decided to take my figures for these items as the basis for his report.

I had in mind at that time a plant which would contain:—

Three 3,000-kw. furnaces for smelting ore.

Three 300-kw. furnaces for smelting ferro-alloys.

Two 1,500-kw. furnaces for making steel.

At first, however, the building was to be large enough for two 3,000-kw. and three 300-kw. furnaces; and only one of the 3,000-kw. furnaces, together with the three 300-kw. furnaces, were at first to be installed. Unfortunately, Mr. Beckman based his design of the plant and his estimate of the cost of making iron on the smallest equipment considered, which was only intended to be temporary, and on this account his estimate of the cost per ton of making pig-iron is higher than necessary.

Electric Pig-Iron in British Columbia.

Report by Beckman and Linden Engineering Corporation, San Francisco, July, 1918. General Remarks.

The following report is made at the request of, and is based upon figures which have been supplied by Dr Alfred Stansfield, of McGill University, Montreal, and has reference to a possible pig-iron industry in British Columbia. All of the conclusions reached are based upon and deduced from information received in this manner.

Location of Plant.

In British Columbia there is available a considerable amount of developed hydro-electric power, and also a large amount of power which is awaiting development. It would be considered advisable in connection with this investigation to locate the proposed pig-iron plant at a place where already developed power is available, and in such locality that the raw materals essential in this industry are obtainable with the least effort. We may take, for example, such a point as Port Moody, approximately ten miles distant from Vancouver. This community has access to the Canadian Pacific Railway, and also deep-water facilities. The British Columbia Electric Railway Company, Limited, have transmission-lines already in Port Moody. Port Moody has a small electric furnace operating for the manufacture of other products, which would facilitate the obtaining of labor to some extent for the undertaking along the lines suggested.

General Outline of Project.

It is a well-known fact that in Sweden great quantities of pig-iron are manufactured by means of reducing iron ore in electric furnaces, utilizing charcoal as reducing agent. The conditions existing in Sweden and those existing in British Columbia are very similar. It therefore suggests itself that the manufacture of pig-iron in British Columbia should offer opportunities similar to those in Sweden. The project here would be based on four units. The first to be installed would consist of one 3,000-kw. furnace, and possibly three 300-kw. single-phase furnaces; the former furnace for the purpose of manufacturing pig-iron, and the latter furnaces for the purpose of manufacturing ferro-alloys, such as ferro-molybdenum, ferro-chrome, ferro-tungsten, and others. The next step would be the addition of a 5,000-kw. furnace for the manufacture of pig-iron, or it might be thought more advisable to put in a 10,000-kw. furnace for this purpose. The difference in operation and equipment between a 3,000-kw. and a 5,000-kw. furnace is not very material, and would only involve an increase in production, while the operation and equipment of a 10,000-kw. furnace would be materially different and a distinct development over a 3,000-kw. furnace. Of course, the investment on a 10,000-kw. furnace would be considerably greater than on a 5,000-kw. furnace, and on that account it might be considered advisable to take an intermediary step. The furnaces would be built in such a manner that they could easily be adapted to manufacturing other alloys, such as ferro-silicon. The purpose of this would be to make the plant as flexible as possible, so that in case the price of pig-iron went down the plant could be used economically for other purposes.

Raw Materials.

In the manufacture of pig-iron the essential raw materials are:—

A. Cheap electric power.

B. Iron ore.
C. Reducing agent, such as charcoal.
D. Fluxing agent.
E. Electrodes.

A. **Hydro-electric Power.**—The amount of power necessary to produce 1 ton of pig-iron in the electric furnace is dependent to a great extent upon the purity of the ores. The iron ore which is available for this undertaking would consume approximately 0.5 horse-power per year per ton of pig-iron. In case the ore was concentrated up to 65 per cent iron content, it would take 0.4 horse-power per year per ton of pig-iron. It is apparent from the following cost data that the power cost is one of the large items, and to make such an undertaking successful it is essential that low power prices are obtainable. It is understood that the British Columbia Electric Railway Company, Limited, has available 10,000 horse-power, 60-cycle power, that could be put into service immediately. Later developments of this industry would necessitate the development of new hydro-electric power sites in close proximity to raw materials.

B. **Iron Ore.**—The raw material on which the whole industry is based is the iron ore. There are a number of iron-ore deposits in British Columbia on the mainland, as well as on the islands, and it would be a question of its availability to Port Moody which would partially govern as to its use in this undertaking. The ore which has been suggested is a magnetite ore containing lime of an average analysis of:

	Per cent.
Iron	50 to 55 (Fe_3O_4 69-76%).
Silica	5 to 6
Alumina	4
Phosphorus	0.02
Sulphur	0.1
Calcium carbonate, etc.	15 to 21

The ore is claimed to be practically self-fluxing and would on that account not necessitate the use of any fluxing agent whatsoever. In a general way this ore is low in its iron content for a very successful pig-iron operation. If there were some ore of higher grade available and at a low price, it would be strongly advisable to consider these deposits in preference to the iron ore under discussion. There is, though, a means by which this ore could be brought up to a higher degree of purity, which would involve a concentrating plant and the sintering of the obtained concentrates. This would, of course, increase the cost of the ore, and would give a higher iron content of ore material to work with, which would increase the output per horse-power year in the electric furnace. It would therefore appear that, if no other ore is available, a concentrating plant would be advisable.

C. **Reducing Agent.**—In the Swedish practice where electric pig-iron is produced charcoal is used as a reducing agent. This is obtained as a by-product from the large lumber and timber operations in Sweden, where pine, spruce, and fir are handled, and there is no timber operation in Sweden of any kind where the refuse is not turned into charcoal either in a by-product charcoal-oven or by pit-charcoaling. British Columbia, as we understand it, has large timber operations, as well as large stands of timber, that in many cases are worthless for timber purposes. These waste lands might be gone over and the timber turned into charcoal, as well as by-products, such as alcohol, acetic acid, creosote-oil, and also turpentine. The creosote-oils are used extensively in flotation purposes where the metal values are separated from the gangue. Charcoal obtained in such a manner, either in by-product coke-ovens or in pit-charcoaling, contains approximately 73 per cent fixed carbon.

British Columbia holds in its bituminous-coal deposits another reducing agent that under special conditions may be used to advantage. It is high in ash and reported to contain 50 per cent fixed carbon.

It has also been suggested as a possibility to utilize some of the oil-wastes obtainable on the Pacific coast as a reducing agent in making pig-iron. This material contains practically no ash and about 70 per cent of fixed carbon.

D. **Fluxing Agent.**—As has been explained under the heading "Iron Ores," the iron ore proposed to be used in this undertaking would not need any fluxing material. Limestone, though, as a rule is used for this purpose, and is available at various points accessible to Port Moody in a purity suitable for this operation.

E. **Electrodes.**—All electric-furnace operations for the reduction of ores are dependent on the supply of electrodes. Electrodes are the means by which the electric current is made available in the furnace. There are plants on the Pacific coast which are manufacturing electrodes, and there are large manufactures of electrodes in the East, both in Canada and the United States. It would seem as though an undertaking of this kind in British Columbia should depend upon its electrode-supply from a Pacific Coast source, and it would be advisable to make an early arrangement with the manufacturers there for this essential.

General Plant Layout.

The plant would be composed of the main furnace building, adjacent to which would be the transformer building. The furnace building would give ample space for the furnace and the necessary electrical connections, as well as the casting-floor on to which the pig-iron would be tapped. This building would have a big electric travelling crane, and also the necessary tracks for the purpose of moving raw materials about and moving the finished products. The initial size of the building would be one which could house a 3,000-kw. furnace and three 300-kw. single-phase furnaces. Buildings, such as storehouse, laboratory, office, wash-house, etc., would be placed at convenient points on the ground. The necessary trackage would have to be laid out in the yards for the handling of all materials and incoming and outgoing shipments. Ample storage-space would be necessary in the yards for the storing of raw materials. There should be approximately sixty days' supply of iron ore in stock, amounting to approximately 4,000 tons. Storage-space should also be provided for a large tonnage of charcoal. The amount that would have to be kept in storage would depend upon the physical conditions surrounding the plant and the accessibility to the charcoal-producing installations. It would be advisable to plan for the necessary roof-sheds to cover two to three months' supply of charcoal. In case any fluxing agent should be needed, space should be provided for the storage of same. Electrodes could be stored in suitable numbers in a small building. To handle efficiently the raw materials and finished product from stock-piles to dump-cars, etc., a locomotive crane would be needed.

Type of Furnace.

The type of electric furnace in which pig-iron is

made in Sweden has a close resemblance to the shaft-furnace. The shaft carrying the burden is supported by braces, and the reduction takes place in a big bowl at the bottom of the shaft, into which the electrode projects. There is a heavy strain on the structure in general, and the refractory roof of the furnace itself receives very severe treatment and frequently needs rebuilding. It has been carefully considered in this connection that it would be advisable to try out a simpler furnace very similar to those used in the manufacture of ferro-silicon and ferro-manganese —a simple 3-phase open-pit furnace. By installing this kind of a furnace and holding the Swedish shaft-furnace in reserve, if the tests works out as anticipated, a saving in installation will take place and a step forward will have been made in the manufacture of pig-iron. It is expected to produce in such a furnace grey pig-iron containing 3 to 4 per cent carbon, 2 to 3 per cent silicon, 0.05 per cent sulphur, and 0.5 per cent phosphorus. If the results do not come up to expectations, the furnace can readily be adapted to manufacturing ferro-silicon or ferro-manganese and a duplication of the Swedish furnace can be installed. The Swedish shaft-furnaces are beyond the experimental stage, working successfully day in and day out in manufacturing white pig-iron. Some trouble has been encountered in manufacturing grey pig-iron in these furnaces. The white pig-iron, though, is used very successfully in open-hearth furnaces and in electric steel manufacture.

Cost of Plant.*

(At 1918 Prices of Apparatus and Construction.)

One 3,000-kw. 3-phase furnace, installed, including casing, electrode-holders, jib-cranes, regulators, and foundations ..	$ 15,000
Four 1,000-kw. single-phase, 33,000-volt primary, 60-cycle oil-insulated and water-cooled transformers, installed, with from 60 to 120 volts in 5-volt steps on the secondary side (one of these transformers is spare)	26,000
One set low-tension busses for 3,000-kw. furnace, installed	5,000
One set high-tension busses for 3,000-kw. furnace, including oil-switches, switch-board and meters	6,000
Three 300-kw. single-phase furnaces, installed, including casing, electrode-holders, and regulating device	10,000
Four 300-kr. 33,000-volt primary, 60-cycle, single-phase, oil-insulated and water-cooled transformers, installed, with a range of from 70 to 100 volts in 5-volt steps on the secondary side	10,000
Three 50-kw. single-phase, 60-cycle, 33,000 volts to 440 volts air-cooled transformers, installed, with switchboard (to be used for industrial purposes around plant)	2,000
One 25-kw. motor-generator set for regulators, etc., installed	2,000
Three sets low-tension busses for 300-kw. furnaces	1,500
One furnace building, built entirely of reinforced concrete, including electric travelling crane, tracks, metal-handling equipment, etc.	35,000
One transformer building, built entirely of reinforced concrete	10,000
One shipping-store building of wood and stucco exterior finish	7,000
One laboratory with complete equipment..	7,500
One store-room and change-room building, built of wood and exterior stucco finish, including steel lockers, toilets, wash-basins, and shower-baths	8,000
One machine-shop with equipment	10,000
One office building	3,000
One gate-house with time-clock and time-keeper's office	500
Railroad tracks, industrial track, ore-handling equipment, water-supply, sewerage, fence and industrial lighting, etc.	25,000
Land, 4 acres	4,000
Total	$225,000
	$187,500
Engineering and contingencies, 20 p.c.	37,500

* In this cost estimate is not included ore-concentrating and sintering plant, nor charcoal plant.

It is well to point out that the above figures cover the cost of a plant that is built entirely of permanent construction. Permanent-construction figures in the first cost are higher than any temporary work, of course; but due to the great fire risk of temporary work, such as wooden construction, it is deemed more advisable to make the larger initial investment to cut down the maintenance cost of a temporary plant.

The electrical equipment selected and put into this estimate is such that, according to our experience with identical design and equipment, a power factor can be obtained on the power company's line as high as from 90 to 92 per cent.

Cost of Production.

Two sets of figures have been made out on the cost of production of pig-iron. The pig-iron which is supposed to be produced is grey foundry pig-iron, and would have a market value of $35 per ton at the plant. The figures which have been worked out are based on crude ore and concentrated ore, assuming that the crude ore would be obtained in one case for $4 per ton, and in the other case increased to $6.45 per ton by concentration. Another set of figures is based on price of crude ore at $1.50 per ton, and concentrated ore at $3.20 per ton. This includes the cost of concentrating and sintering, amounting to $1.25 per ton concentrate. The power is assumed to be delivered at the switchboard at $15 per horse-power year. The reducing agent—charcoal—is assumed to be obtained at a price of $6 per ton ($6 per ton being the price for British Columbia coal), and $7 per ton the price of oil-waste carbon. In the following figures charcoal only has been taken into consideration, though the amounts of the different reducing agents needed to reduce 1 ton of 55-per cent ore are as follows:—

	Ton
Charcoal containing 73 per cent fixed carbon	0.5
British Columbia coal, 50 per cent fixed carbon	0.8
Oil-waste carbon, 70 per cent fixed carbon....	0.6

In producing from an ore containing 55 per cent iron, 2 tons per horse-power year is estimated as a safe figure upon which to base calculations. On ore containing 65 per cent iron, 2.5 tons per horse-power

year production is assumed a safe figure upon which to base calculations. It is evident from the above that operating with a 55 per cent ore in a 3,000-kw. furnace would give an annual production of 8,000 tons of pig-iron, while the annual production obtained in a 3,000-kw. furnace with concentrated ore would be 10,000 tons of pig-iron. The operation of the furnace would be continuous twenty-four hours' operation, and would be operated in three shifts. The costs would be as follows:—

$4 per Ton Crude Ore (50 Per Cent Iron).

Coal, ½ ton charcoal at $6	3.00
Electric power, 0.5 h.p. year at $15 per h.-p. year	$7.50
Iron ore, 2 tons at $4 per ton	8.00
Electrodes, 20 lb. per ton of metal produced at 10 cents a pound	2.00
Labor	8.00
Supplies	1.00
Plant and office general expense	5.00
Interest on investment and depreciation, 20 per cent	4.50
Total	$39.00

$6.45 per Ton Concentrated Ore (65 Per Cent Iron.)

Electric power, 0.4 h.-p. year at $15 per h.-p. year	$6.00
Iron ore, 1.54 tons at $6.45 per ton	9.93
Coal, ½ ton charcoal at $6	3.00
Electrodes, 20 lb. per ton of metal produced at 10 cents a pound	2.00
Labor	6.40
Supplies	1.00
Plant and office general expense	5.00
Interest on investment and depreciation	2.81
Total	$36.14

Total Production, 8,000 Tons Pig-Iron.

Gross earnings at $35 per ton	$280,000
Cost to manufacture at $39	312,000
Deficit	$32,000

Total Production, 10,000 Tons Pig-iron.

Gross earnings at $35 per ton	$350,000
Cost to manufacture at $36.14	361,400
Deficit	$11,400

Crude Ore at $1.50.

Electric power, 0.5 h.-p. year at $15 per h.-p. year	$7.50
Iron ore, 2 tons at $1.50 per ton	3.00
Coal, ½ ton charcoal at $6	3.00
Electrodes, 20 lb. per ton of metal produced at 10 cents a pound	2.00
Labor	8.00
Supplies	1.00
Plant and office general expense	5.00
Interest on investment and depreciation, 20 per cent	4.50
Total	$34.00

Concentrated Ore at $3.20.

Electric power, 0.4 h.-p. year at $15 per h.-p. year	$6.00
Iron ore, 1.54 tons at $3.20 per ton	4.93
Coal, ½ ton charcoal at $6	3.00
Electrodes, 20 lb. per ton of metal produced at 10 cents a pound	2.00
Labor	6.40
Supplies	1.00
Plant and office general expense	5.00
Interest on investment and depreciation, 20 per cent	2.81
Total	$31.14

Total Production, 8,000 Tons Pig-iron.

Gross earnings at $35 per ton	$280,000
Cost to manufacture at $34	272,000
Net profit	$8,000

Total Production, 10,000 Tons Pig-Iron.

Gross earnings at $35 per ton	$350,000
Cost to manufacture at $31.14	311,400
Net profit	$36,600

It is from these figures very apparent that it would be impossible to go into the pig-iron manufacture using unconcentrated ores; while operating with concentrated ores at $3.20 shows a reasonable return.

Electric Steel-Furnace.

It would seem as a logical arrangement in connection with the pig-iron furnace to establish an electric steel-furnace, in which special steel will be manufactured. There is no possibility at the present time for an iron industry on the Pacific coast to compete with Eastern production of heavy steel material. There is a field here legimitate and profitable to manufacture special shapes of light rolled metal, as well as steel castings. With all the mining industries going on in the West, and with the ship-building industries growing out here at a pace, there is an urgent need for special alloy steel and special electric steel castings. The raw materials for the alloy steel are available on the Pacific coast, and could be readily smelted and put into steel products. The material which comes out of the pig-iron furnace would be carried in a ladle in a molten condition to the steel-furnace, and in such a manner cut down the melting cost and refining cost of the finished steel product. It is certain that better financial success would be made by installing an electric steel-furnace in conjunction with the pig-iron manufcture and a rolling-mill than by operating the plant exclusively on pig-iron.

Ferro-Alloy Furnaces.

The three 300-kw. furnaces can be used for the manufacture of alloys which could easily be used in the production of steel. The operation of these furnaces could be carried on easily in conjunction with the large 3,000-kw. furnace.

Conclusions.

The foregoing report shows the following:—

(1.) That conditions in British Columbia lend themselves well to the manufacture of pig-iron under special conditions.

(2.) That the successful manufacture of pig-iron in British Columbia is dependent upon a low-priced iron ore.

(3.) That British Columbia holds by virtue of its

large supply of timber and its deposits of bituminous coal, two reducing agents suitable for the manufacture of pig-iron.

(4.) That cheap hydro-electric power delivered at a figure not higher than $15 per horse-power year is essential.

(5.) That the concentrating and sintering of concentrates before the ore is used in the furnace is essential in the manufacture of pig-iron from British Columbia ore.

(6.) That a steel industry in conjunction with the pig-iron furnace and alloy-furnaces is a more advantageous undertaking than a pig-iron industry exclusively.

Beckman & Linden Engineering Corporation,
(Signed.) J. W. Beckman, President.

Cost of Manufacturing Ferro-Silicon.

(Appendix to Beckman & Linden's Report.)

In the foregoing report reference is made to the possibility of utilizing the furnace suggested there for the manufacture of ferro-silicon. The following figures would indicate the cost of producing 1 ton of metal and the returns which would be obtained:—

Power at $15 per horse-power year .	$15.00
Quartz, 2,400 lb. at $3.60 per ton..	4.20
Coal, 1,210 lb. at $6 per ton	3.63
Turnings, 1,500 lb. at $10 per ton..	7.50
Electrodes, 60lb. per ton of metal at 10 cents per pound	6.00
Labor	16.00
Supplies	1.00
Plant and office general expense ..	5.00
Interest on investment and depreciation, 20 per cent	9.38
Total	$67.71

The total output of this plant would be about 4,000 tons of 50 per cent ferro-silicon per year, and, assuming that 50 per cent ferro-silicon sold for $150 per ton, the net profit would be:—

Gross earnings at $150 per ton.. ..	$600,000
Cost to manufacture at $67.71 per ton	270,840
Net profit	$329,160

APPENDIX XII.

A New Method of Producing Electric-Furnace Iron.

The operation of smelting an ore of iron for pig-iron includes two distinct steps, which are, however, carried out in the same furnace and to some extent simultaneously.

The first step is one of reduction, in which the ore consisting largely of oxide of iron, is converted into metallic iron by means of carbon or carbonaceous gases. The second step is one of fusion, in which the metallic iron, already formed, is melted and becomes pig-iron. The gangue of the ore, together with the flux, is also melted and forms slag*. The first step can be carried out at a moderate temperature of, say 700° or 800° C., while the second step needs a very high temperature, say, 1,400° or 1,500° C. Although the first step can be effected at a lower temperature than the second, it consumes about twice as much heat, measured in calories or kilowatt-hours, and it is this large requirement of heat that renders so costly the electric smelting of iron ores. That this is practically true will be made clear when I mention that a ton of steel can be melted in an electric furnace by means of 600 or 700 kilowatt-hours, whereas about 2,500 kilowatt-hours are needed to produce a ton of pig-iron from the ore.

In the electric furnace both steps of the smelting operation are carried out more or less simultaneously, and at a high temperature; and this causes waste of heat and unnecessary expense, particularly as the heat is derived from costly electrical energy. The smelting operation produces a large amount of hot carbonaceous gases, which in a simple electric furnace escape and burn above the charge. These gases may be utilized for heating and reducing the ore, and the Swedish furnace is provided with a large shaft for this purpose. A careful analysis shows, however, that the most efficient furnace of this type is decidedly inefficient from an economic point of view; and we are led to consider whether better results can be obtained in some other way.

I have thought, for a long time, that greater economy could be obtained by separating the two stages of the smelting process and carrying them out in separate furnaces. The ore, crushed to a coarse powder, would be reduced to the metallic condition by means of carbon in one furnace using fuel-heat, and the metallic powder would then be melted electrically. It appears that in this way a pig-iron of electric furnace quality could be obtained more cheaply than by direct electric smelting.

Until recently I had no experimental evidence in regard to the preliminary reduction of the ore, and had intended to undertake a series of experiments for this purpose; but during the last few months I have obtained information with regard to this point, which makes it seem probable that the process can be carried out practically, and that a decided economy will be gained by its use.

The possibilities of the process will be made clear by the following numerical discussion:—

The reduction of magnetite by carbon will probably follow the equation: $Fe_3O_4 + 3C = 3\ Fe + 2\ Co + CO_2$. This requires 115,000 calories for the reduction of 1 kilogram molecular weight of magnetite, or 686 calories per kilogram of iron. This corresponds, if electrical heat is used, to 800 kilowatt-hours per metric ton of metallic iron.

The heat required to melt 1 ton of cast iron would be (theoretically) about 300 kilowatt-hours, but for the production of foundry pig-iron there would be needed an additional 175 kilowatt-hours for the production of silicon, or a total of 475 kilowatt-hours for the melting operation. Thus in round numbers there will be needed.

	Kw. Hrs.
For reducing the iron ore to metal	800
Converting this into foundry pig-iron..	500
Total	1,300

It will be noticed that I have made no specific allowance for melting the slag. This is because the gangue will be practically eliminated by magnetic treatment before fusion, and thus there will be scarcely any slag to melt.

*Actually the second stage is more complicated than I have indicated, as the iron in fusion absorbs carbon and silicon to form pig-iron, the silicon itself being derived from the silica in the ore.

In electric furnaces a working efficiency of at least 70 per cent. can usually be obtained, and therefore we find as the actual operating charges for the two stages:—

	Kw. Hrs.
For reducing the iron ore to metal	1,140
For reducing silicon and melting the iron ..	710
Total	1,850

The total power requirement shows a decided economy when compared with the 2,500 kilowatt-hours that would be needed for the direct smelting of the ore, even after making allowance for the cost of crushing, magnetic treatment, and double handling of the material. The first or reducing stage can, however, be carried out by means of fuel-heat instead of electrical heat without detracting from the purity of the product. The operation would have to be carried out in some kind of a muffle-furnace, as the reduced metal must be protected from the air and from furnace gases, and the efficiency of the heating fuel would consequently be very low. As, however, cheap fuel, such as waste wood, can be employed, this will not cause any serious expense.| The heat theoretically needed for the reduction of the iron ore is 686,000 calories per metric ton of iron; allowing 25 per cent. efficiency, this would mean 2,744,000 calories, which would be furnished by 0.4 ton of a low grade of coal. It would appear safe, therefore, to allow for this purpose ½ ton of local coal or an equivalent amount of waste wood.

Dr. Trood and Mr. W. A. Darrah have carried out a series of experiments at Heroult, in California, on the reduction of pure magnetite ore to metallic iron. The work has been done in a small furnace making a few pounds per hour of reduced iron. This furnace was heated electrically, and in this way an exact determination could be made of the heat that was supplied to it. There was under construction at the time of my visit a large furnace for the reduction of ore which was to be heated by means of fuel. Since my visit Mr. Darrah has been made superintendent of the plant, and this has no doubt interfered with the progress of the experiments. He has, however, written me the following letter with regard to the cost of operating the Trood-Darrah process. I assume that the power-consumption used in this estimate is deduced from their small-scale experiments, and that the other expenses refer to a plant making 100 tons of metallic iron daily.

Noble Electric Steel Company,

Heroult, Shasta County, Cal., October 23rd, 1918.

"Regarding the questions which you have raised, I have to advise as follows:—

"(1.) We have made a very substantial success in reducing magnetite-iron ores to metal by heating to a moderate temperature with carbonaceous reducing agents.

"(2.) Reduction begins in the neighborhood of 700° C., but in order to carry the reaction to completeness, as well as to minimize the time required, we find it expedient to operate at approximately 800° C.

"(3.) For a perfect reduction of particles the size of coarse sand, with the magnetite ore that we are using we find that three hours are required. The time will vary considerably with the different grades of ore, different reducing agents, and different temperatures. Powdered charcoal is the most satisfactory reducing agent, but, of course, is not the only successful one.

"(4.) Total cost per ton of iron product, making ample allowance for power, fuel, etc., about $19.

"The costs are divided as follows:—

Item.	Cost per Ton.	Quantity required	Total Cost Per Ton of Iron.
Power for drying and reduction	½ cent per kilowatt-hour	1,200 kilowatt-hours	$6 00
Charcoal	$25 per ton	570 lb.	7 10
Ore	$3 per ton	2,760 lb.	4 15
Crushing materials	50 cents per ton	......	69
Handling materials	50 cents per ton	......	69
Labour and supervision	......	......	50
Interest and Depreciation, $20,000 Investment	......	......	10

"The above cost may appear rather high, depending upon your local conditions. It is, of course, a direct result of the price of such materials as reducing agents and iron ore, which you will note total considerably over 50 per cent. of the entire cost. The power cost, you will note, is less than one-third of the total cost.

"Dr. Trood and I consider it quite feasible to reduce the iron by our processes, and melt it either electrically or after briquetting in an open-hearth furnace. It is then perfectly feasible to make either pig-iron or steel, as the market may demand."

With regard to Mr. Darrah's estimate, I may state:—

(1.) Assuming the ore to contain 67.8 per cent. of iron (published analysis), 2,760 lb. of ore would only yield about 1,870 lb. of metallic iron. It would appear from this that the estimate does not refer to a ton of pure iron, but to a 2,000-lb. ton of an impure iron product containing about 93 per cent. of iron. As this is about the percentage in foundry pig-iron, we need only increase the estimate by about 15 per cent to provide for the change from the short ton to the long ton and for the mechanical losses in the various operations.

(2.) Mr. Darrah's estimate of 1,200 kilowatt-hours, if increased by 15 per cent., would give 1,380 kilowatt-hours, whereas my estimate, based on calculation, was 1,200 kilowatt-hours. We should for the present take the larger figure, which increases the cost by 90 cents.

(3.) The estimate of 570 lb. of charcoal, increased by 15 per cent., comes to 655 lb. This figure is supported by calculation from the equation I gave above, and I am estimating on a consumption of 1-3 net ton of charcoal; the cost of this in British Columbia will be only about $2.

(4.) The remaining items of cost must be increased by about 50 per cent. on account of the larger amount of ore to be handled. Apart from this, I cannot check them in any detail, but suppose that they would be rather higher under British Columbian conditions. The charges seem to be very small, but it should be remembered that the operation will be continuous and mechanical throughout; there will be no hard labor required, and the cost for labor, superintendence, and maintenance of plant should be small.

The following estimate of the cost of making 1 long

ton of metallic iron in the form of powder by the Trood-Darrah process has been prepared in view of conditions in British Columbia:—

Cost of One Long Ton of Metallic Iron, Using Electrical Heat at ½ Cent per Kilowatt-Hour.

Ore, 2.2 tons at $4	$8 80
Charcoal, 1-3 ton at $6	2 00
Power for heating, 1,380 kilowatt-hours at ½ cent	6 90
Crushing materials at 50 cents per ton ..	1 10
Handling materials at 50 cents per ton ..	1 10
Labour and supervision	85
Interest and depreciation	25
Total	$21 00

Inthis estimate I have taken 2.2 tons of ore instead of 2 tons in order to cover the loss in magnetic concentration which would form the first step in the process.

If fuel can be used for heating in this operation the cost will be further reduced, thus the heat should be obtainable by the use in gas-producers of ½ ton of low-quality coal costing, say, $4 per ton. The cost of heat would thus be $2, or at the outside $2.50, and the total cost of the iron $16 or $17 per ton.

With regard to these figures, I must state clearly that, although I have full confidence in Mr. Darrah's statements, yet the operation of the process must be demonstrated on a working scale and its applicability to British Columbian ores must be shown before a commercial enterprise can be undertaken.

I should also state that I believe that foundry pig-iron can be obtained, conveniently and economically, by melting the iron powder with fluxes in an electric furnace. It will be necessary, however, to confirm this point experimentally, and also to ascertain whether the sulphur originally present in the ore will be removed sufficiently well by the proposed process.

The following estimate will give some idea of the cost of 1 ton of foundry iron obtained by melting the reduced powder in an electric furnace:—

Cost of One Long Ton of Foundry Pig-Iron.

Reduced metallic powder	$17.00
Electric power, 750 kilowatt-hours at ½ cent	3.75
Charcoal, 1-10 ton at $6	.60
Electrodes, 7 lb. at 8½ cents	.60
Fluxes and supplies..	.55
Labor	2.00
Management	1.00
Interest and overhead charges	1.50
Total	$27.00

Another favorable feature of the reduction process is that the metallic powder can be melted in electric furnaces for the production of steel without the need of first turning it into pig-iron. In this way one step of the usual process is eliminated and electric-furnace steel may be produced at very reasonable figures.

Reduction of Iron Ore by Hydrogen.

As having a bearing on the above process, I add a brief account of the reduction of iron ores by means of hydrogen. Mr. A. T. Stuart, of Toronto, invented an improved form of apparatus for the production of hydrogen and oxygen by the electrolysis of water. In trying to find uses for the hydrogen, he discovered that iron ores are reduced to metal by means of hydrogen at so low a temperature as 700° C. The process is very convenient, because the hydrogen can be passed again and again through the ore, so that the gas is perfectly utilized. Such a process, however, would only be possible if hydrogen could be obtained extraordinarily cheaply. To produce it by electrolysis would need unusually cheap electric power, and the ore could be smelted directly with less power than would be needed to make the hydrogen and to carry out the reduction with its aid. The only condition under which the process could be employed would be if there were available during off-peak periods of a power plant large amounts of direct current power, which could be obtained at a very low price, and if, in addition, there was a satisfactory market for the electrolytic oxygen, so that the hydrogen might be regarded as a by-product. I must add, also, that Mr. Stuart's experiments were made on haematite ores, and it is likely that magnetites may not be reduced so easily or at so low a temperature. One feature of the process which may prove important is that the hydrogen used to reduce the iron also serves to remove from it phosphorus and sulphur in a gaseous form.

Steel Direct From the Ore.

(A Process described by F. T. Snyder.)

I conclude this Appendix with an extract from a paper on "Steel Direct from the Ore," which was sent to me recently by Mr. F. T. Snyder, of Chicago, the inventor of the Snyder electric steel-furnace. I quote Mr. Snyder, as I consider that his account is of interest in connection with the present investigation, but I do not endorse his process or assume any responsibility for his statements:—

"To expose sufficient surface for rapid reduction the ore is crushed to ¼ or 1-8 inch in diameter. From an ore-storage bin it is fed into a cylindrical kiln in which the ore is dried and heated to 700° C. under oxidizing condition. The sulphur contents of the ore will be substantially eliminated in this preliminary roasting. At 700° C. the ore falls into a reducing-kiln, in which it is exposed to the action of carbon-monoxide gas, which reduces the iron oxide to metallic iron sponge. This iron sponge is conveyed without exposure to air, and while still hot, to an air-tight electric furnace. The reducing carbon-monoxide gas is generated in a gas-producer from powdered coal giving a hot gas low in carbon dioxide. At the part of the reducing-kiln where the iron ore enters, this gas leaves the kiln with about the same composition as the gas leaving the top of a blast-furnace. Part of this gas passes into the roasting-kiln, where it is burned with air from a fan to furnish the heat required to raise the ore to 700° C. before it enters the reducing-kiln. The balance of the gas from the reducing-kiln is burned under a boiler, and with the steam the necessary power is produced for the electric-smelting furnace. By a fortunate coincidence the amount of gas available is somewhat more than the amount needed by the electric furnace.

"This arrangement of equipment meets the three fundamental difficulties of the earlier attempts to make steel direct from ore, and retains the great commercial advantages of the direct method. By the use of fine ore in rotating-kilns, which both expose the ore to the acting gases and at the same time convey it, the difficulty of getting the iron sponge out and trapping the gas is made easy by the low pressure required to pass the gases through the kilns. The electric furnace melts the sponge without oxidation and eliminates the second difficulty. The use of

a preheating-kiln which is separate from the reducing-kiln makes it possible to remove the reducing gases from contact with the ore before the gas is cooled to a temperature at which carbon-deposition begins, and furnishes a sponge that is practically free from carbon and ready to melt direct to steel. As the reduction is entirely by carbon-monoxide gas, no solid carbon coming in contact with the ore, the silica, phosphorus, and titanium in the ore are not reduced, but remain in their original form and are melted in the slag in the electric furnace, substantially none of them entering the steel.

"Compared with the direct method of smelting iron ore with electricity, the kiln method, with electric-furnace finishing has the advantage of a much lower electric-power consumption. The kiln method uses 600 kilowatt-hours per ton of steel produced for all power purposes. The direct electric smelting uses 2,000 kilowatt-hours for the electric smelting producing pig-iron, and 500 kilowatt-hours for the electric-furnace operation of changing the electric pig-iron to steel. When the weight of the electrodes for the pig-iron furnace are taken into account, and the fact that the kiln method uses charcoal from twigs and leaves, the total average of timber required for both methods is approximately the same. A production of 25 tons per day requires 1,000 kw. of power plant for the direct-steel method, and 3,000 kw. for the electric pig-iron method. The difference in the investment cost for power-plant construction is 50 per cent greater than the total cost of the kiln plant, exclusive of its power plant. If water for power is available without cost, the burden of the investment cost renders the electric pig-iron method non-commercial in comparison with the direct-steel method.

"The economic advantages of this method are:—

"(1.) The use of iron ores of inferior composition. Sulphur is eliminated in the preliminary roasting. Silica, phosphorus, and titanium enter the slag.

"(2.) The use of fuel of inferior quality. As the fuel is burned in a producer in powdered form, raw coal, coke, or charcoal may be used. Sulphur in the fuel enters the reducing gas as sulphur-monoxide gas, which is without action on the iron at the temperatures used. Powdered fuels are in reliable use with ash as high as 20 per cent.

"(3.) The production of steel of electric-furnace quality. This is substantially higher in tensile strength, elastic limit, percentage of elongation, and resistance to shock than is Bessemer or open-hearth steel of the same analysis.

"(4.) The recovery of a high percentage of the iron in the ore. Practically all the iron in the ore passes into the steel, as the electric-furnace melting makes it possible and the production of good steel makes it necessary to produce a slag substantially free from iron. With the present blast-furnace, open-hearth or Bessemer combination from 10 to 15 per cent of the iron in the ore is lost in the slags produced.

"(5.) Existing methods use about 1 ton of coke in the blast-furnace per ton of pig-iron. This coke requires for its production 1 2-3 tons of raw coal. To turn this ton of pig-iron into steel requires an additional 1-3 ton of raw coal burnt in gas-producers. This is a total consumption of 2 tons of raw coal per ton of steel produced. The direct method, including the gas for electric power and for roasting, requires 1 ton of raw fuel. As the fuel is used powdered, if charcoal is made the small twigs and the leaves may be carbonized as well as the larger pieces, substantially doubling the steel produced per acre of timber.

"(6.) The capital investment, including electric-power plant, is about two-thirds that of the blast-furnace, open-hearth combination for the same output.

"(7.) The production cost per ton of steel ingots is about 80 per cent of the older practice.

"(8.) Plants for small production are practical with the direct-steel method, outputs as low as 25 tons per day being efficient.

"(9). Production may be stopped or started in a few hours if necessary, to meet market or traffic conditions, without plant deterioration, and without the production of considerable quantites of lower-quality product.

"(10.) As the equipment is low, the entire plant may be traversed by travelling cranes making repairs rapid and low in cost. This latter is also aided by the general low temperatures of operation.

"(11.) As the operation is mostly mechanical, the amount of labor required is small. Skilled labor required only for supervision.

"(12.) As the gas-pressure used is low and no large quantity of molten material is held at a time, the safety of operation is materially greater than with the blast-furnace and open hearth."

APPENDIX XIII.

Auxiliary Industries.

In view of the limited market for foundry pig-iron in British Columbia, it will be essential to make other products, so as to increase the output of the plant. For this purpose an additional output of low-silicon pig-iron can be made, and this can be melted with steel scrap for the production of steel. Ferro-alloys, such as ferro-silicon, ferro-manganese, and ferro-chrome, can also be made in an electric-smelting plant. These auxiliary industries not only increase the general output of the plant, thus reducing, proportionately, the overhead charges, but are themselves likely to yield a higher profit than the production of pig-iron. The production of ferro-manganese and ferro-chrome in the electric furnace depends upon a supply of ores of manganese and of chromium. Quartz is required for the production of ferro-silicon.

Ferro-Alloys.

Ores of Manganese and Chromium.—I have been furnished by Mr W. F. Robertson with the following information, which indicates that there would be a sufficient supply of ores of these metals of a grade suitable for the production in electric furnaces of ferro-manganese and ferro-chrome. Quartz for the production of ferro-silicon can also be obtained.

Report on the Ore-Deposit by Mr. Langley.

"The property, consisting of ten claims, is situated

The Curle Manganese Group.

Report by A. G. Langley, Resident Engineer, Revelstoke, June, 1918.

Report of Assays by the Provincial Government Assayer.

Sample.	Description.	Manganese Per Cent.	Iron Per Cent.	Phosphorus Per Cent.	Sulphur. Per Cent	Insoluble. Per Cent
11675	Manganese ore sacked for shipment..............	34.5	....	....		
11676	General sample, dumps, ore for shipment........	37.5	....	....		
11677	General sample, dumps, ore for shipment........	36.7	....	....		
11678	General sample ore in-place, No. 2 deposit........	39.0	2.7	Traces	0.13	6.35
11679	Sample high-grade, No. 1 deposit................	49.5	....	....		
11680	Overburden reject.........	17.2	....			
11681	Iron oxide underlying.........	9.7	22.6			

(Signed) D. E. WHITTAKER

at a distance of seven miles from Kaslo and adjoins the Kaslo & Nakusp branch line of the Canadian Pacific Railway.

"The group was staked by A. Curle, of Kaslo, in 1917, and although the ore freely exposed along the old Kaslo-Slocan wagon-road it escaped attention for years, due no doubt to the lack of knowledge of the character and commercial value of the deposit. In February, 1918, the property was bonded by the original owners, A. J. Curle and A. G. Larson, to Col. F. B. Millard, of Spokane.

"Seventeen men are now employed and considerable progress has been made during the last month in developing and winning the ore.

"**Character of the Ore.**—The ore chiefly consists of the soft black or brown oxides, which may be classified as wad manganese, while concretionary psilomelane, though in evidence, is less frequent in occurrence.

"**Ore Occurrence.**—At the No. 1 deposit the ore forms a blanket over the surface of the flat, the average thickness of which is hard to arrive at, for its distribution is uneven and irregular, but can safely be taken as not exceeding 6 inches.

"From where the hill rises above the flat and for about 50 feet up, the gentle slope, the ore, which occurs underlying a few inches of soil, shows about an average thickness of 1½ feet and appears to be of higher grade than that on the flat.

"At the No. 2 deposit the occurrence is similar to that of the No. 1, but appears to be more uniform and to contain a greater tonnage.

"The deposit has not been mined yet, and its area is less outlined than that of the other. In an isolated patch at about 120 feet east of this deposit a small surface cut shows a 2-foot thickness of high-grade ore dipping slightly under a covering of about 3 feet surface wash; at this point a nice tonnage may be developed, but no work has been done to determine its extent.

"**Geology.**—Underlying the manganese-deposit, a layer of about 6 inches of soft material stained with oxide of iron is encountered, and under this a greenish clay containing pebbles and boulders of what is known locally as the Kaslo green schist. No attempt has been made to sink through the clay, which forms the floor of the deposit. Judging by the rock-exposures along the railway-cutting, the whole area is underlain by schists and slates, which have a dip of 53 degrees and a strike of N. 10° W.

"**Origin of the Deposit.**—The primary deposit of manganese probably owed its origin to deep-seated springs arising from a body of intrusive magma. These waters deposited their burden of lime, iron, manganese, and silica in veins and veinlets of the country-rock. During subsequent erosion and oxidation the manganese has been collected by surface waters and redeposited on the benches and gentle slopes of the hillside.

"The iron, being precipitated first from solution, forms the lower layer of the deposit, while the lime may have been an important factor in bringing about the precipitation of the managanese.

"That this secondary deposit is of fairly recent origin is demonstrated by the fact that it overlies glacial drift. The calcareous sinter which is invariably with the manganese, and generally overlying it, no doubt owes its origin to deep-seated springs, of which there are still a few active ones in the vicinity.

"**Mining.**—The ore being soft is easily mined by pick and shovel, but great care has to be exercised in obtaining a grade suitable for shipment, and a certain amount of sorting is necessary.

"On account of the difficulty in getting cars, no ore had been shipped up to the time of my visit. It was the intention of the owners to ship to Chicago.

"**Prices.**—The prices which were recently fixed in the United States range from 86 cents to $1.30 per unit for ore containing from 35 to 54 per cent. metallic manganese. (Refer.: Eng. & Mining Journal, June 8th, page 1053. Freight rate to Chicago, $11.20 per ton.

"**Samples.**—No. 11675, taken from 800 sacks for shipment; Nos. 11676 and 11677, generaly grab sample of all dumps of ore, containing 110 tons; No. 11678, sample taken from a number of test-holes on No. 2 deposit; No. 11679, samples across 15-inch width of high-grade ore, No. 1 deposit; No. 11680, sample of overburden reject; No. 11681, sample of oxidized material underlying manganese.

"**Estimate of Available Ore for Shipment.**—Estimates of ore in-place are based on the assumption that 40 cubic feet equal 1 ton.

	Tons.
Total ore in No. 1 deposit	730
Less extracted	160
	570
Total ore in No. 2 deposit	835
Total	1,405

"On account of the irregularity of the deposit and the unsystematic way in which it has been prospected, the estimate is partly based on the amount that has been extracted from various areas, and where the deposit showed regularity, upon the cubic content.

"**Conclusion.**—So far the only bodies discovered that might be considered of commercial importance are the Nos. 1 and 2 deposits as shown on the plan, and although there are manganese indications in patches outlying these areas, at the present time there is not enough exposed to allow one to make an estimate of the possible ore which may or may not exist under a covering of surface wash, but the indications do not encourage one to believe that there is any large quantity.

"(Signed.) A. G. LANGLEY,
"Resident Engineer."

Manganese Ore from Dickie's Claim, Cowichan Lake. Samples taken by Mr. Turner, August, 1918.
Report of Assays by the Provincial Government Assayer.

Sample.	Manganese. Per Cent.	Insoluble. Per Cent.	Phosphorus.
No. 1, 4 feet	18.3	66.3	None.
No. 2, 6 feet	55.0	11.0	None.
No. 3, 5 feet	32.8	45.1	None.
Second lens	37.0	38.0	None.

(Signed.) D. E. WHITTAKER.

Mr. W. F. Robertson writes:—

"August 14th, 1918.

"I enclose assay certificate of a manganese-deposit within a mile of the Canadian Pacific Railway and Canadian Northern Railway by wire tram, showing over 6 feet of 55 per cent Mn. ore carrying 11 per cent SiO_2, with 4 feet of lower-grade ore on one side and 16 feet on the other. It looks as if we could guarantee 30 tons a day of best grade within sixty days, and possibly up to 100 tons."

Deposits of Chrome-iron Ore.

Report on Deposit at Scottie Creek by R. W. Thomson, Resident Engineer, Kamloops, May 10, 1918.

Sample 11762 — 22.5 per cent. Cr_2O_3 and 27.2 per cent silica.

Sample 11761—24.0 per cent. Cr_2O_3 and 35.0 per cent silica.

II. Sample from Scottie Creek supplied by Provincial Mineralogist, July, 1918—

No. 1, 12974—40.5 per cent Cr_2O_3, or 28.5 per cent chromium.

No. 2, 12975—42.5 per cent Cr_2O , or 29.5 per cent chromium.

No. 3, 12976—24.8 per cent Cr_2O_3, or 17.0 per cent chromium.

Mr. Robertson informed me that there was an ample supply of this ore.

III. Sample from Juno Claim, Big Sheep Creek, supplied by P. B. Freland, Resident Engineer,

Grand Forks, July, 1918—

Sample 11471—36.0 per cent Cr_2O_3 or 24.6 per cent chromium.

Production of Ferro-Alloys in the Electric Furnace.

The following notes on the technical requirements and the cost of making ferro-manganese, ferro-chromium and ferro-silicon are based on information given me by Messrs. Beckman and Linden. I have, however, been able to compare their figures for the consumption of ore, electric power, and electrodes in some cases with those given in a valuable paper by R. M. Keeney, "The Manufacture of Ferro-alloys in the Electric Furnace," which was presented at the September, 1918, meeting of the American Institute of Mining Engineers. Beckman and Linden's figures refer in most cases to the operation of a 3,000-kw. furnace, and I have therefore made some allowance for increased consumption of power, labour, etc., involved in the proposed use of a furnace of only 300 kw.

Ferro-Manganese.

This is made by smelting in an electric furnace a mixture of manganese ore, steel turnings, lime rock, coke, and charcoal. For the production of a long ton of 80 per cent ferro-manganese from an ore containing 43 per cent of manganese the following amounts would be needed, using Beckman and Linden's figures:—

	Lb.
Manganese ore	4,700
Steel turnings	300
Lime rock	1,040
Coke and charcoal	1,400
(B. & L. give petroleum coke	1,125)
Electrodes	100
Power	0.8 h.p. year.

A small single-phase furnace of 300 kw. would turn out about 500 tons per annum, or 1½ tons per day, which would be as much as could be utilized locally.

The following estimate of the cost of 1 long ton of 80 per cent ferro-manganese is based on information supplied by Messrs. Beckman and Linden:—

Manganese ore, 4,700 lb. at $25 per net ton	$ 58.80
Steel turnings, 300 lb. at $10 per gross ton	1.30
Lime rock, 1,040 lb. at $3.50 per net ton	1.80
Coke and charcoal, 1,400 lb. at $8 per net ton	5.60
Electrodes, 100 lb. at 7 cents per pound	7.00
Power, 0.8 horse-power year at $15 per horse-power year	12.00
Labor	8.00
Maintenance	5.00
Supplies	1.50
Plant, general expense	3.00
Office, general expense	6.00
Total	$110.00

R. M. Keeney states that the power-consumption varies from 4,000 kilowatt-hours per long ton in a 3,000-kw. furnace to 7,000 kilowatt-hours per long ton in a 1,000-kw. furnace, which would correspond to 0.72 and 1.27 horse-power years respectively at 85 per cent load factor. He also states that the electrode-consumption is high, ranging from 150 to 250 lb. per long ton of the product when using amorphous carbon electrodes. These results were obtained when smelting ores of about 39 per cent of manganese, and with a consumption of about 1,300 lb. of "coal" per gross ton of product, and about 3 net tons of the 39 per cent ore; the recovery being about 75 per cent.

From other sources I learn that the regular practice in a ferro-alloy furnace of 1,500-kw. over a considerable period has been as follows per gross of 80 per cent ferro-manganese:—

- 2.5 net tons of 40 per cent ore, costing 80 cents per unit.
- 720 lb. coke at $5 per net ton.
- 720 lb. charcoal at $20 per net ton.
- 65 lb. graphite electrodes at 12 cents per pound.
- 0.66 to 0.85 horse-power year of 85 per cent load factor.

The ores available in British Columbia appear from the foregoing reports to contain about 40 per cent manganese, and comparing the various figures given above, I conclude that in a 300-kw. furnace 1 long ton of 80 per cent ferro would need about the following:—

- 40 per cent manganese ore, 2.7 net tons.
- Coke and charcoal, 1,400 lb.
- Electric power of 85 per cent load factor, 0.9 horse-power year.
- Carbon electrodes, 150 lb.

Lime rock, 1,500 lb.
Steel turnings, 300 lb.

An estimate of the cost of 1 long ton of 80 per cent. ferro-manganese based on these figures would be as follows:—

Cost of Making One Long Ton of 80 Per Cent. Ferro-Manganese With $15 Power in a 300-k.w. Furnace.

40 per cent. manganese ore, 2.7 net tons at $25..	$ 67 50
Steel turnings, 300 lb. at $10 per gross ton	1 30
Lime rock, 1,500 lb. at $3 per net ton	2 25
Coke and charcoal, 1,400 lb. at $8 per net ton	5 60
Electrodes, 150 lb. at 7 cents per pound	10 50
Electric power, 0.9 horse-power year at $15 ..	13 50
Labour	8 00
Maintenance	5 00
Supplies	2 00
Plant, general expense	3 00
Office, general expense	6 00
Total	$124 65

If the power were to cost 0.5 cent per kilowatt-hour, the charge for this item would be:—

0.9 horse-power year (0.85 L.F.) at $27.70	$ 25 00
And the final figure for the cost	136 15

Silico-Manganese.

In steel-making it is usually necessary to add ferro-manganese and ferro-silicon to obtain a sound product. As manganese ores usually carry a considerable amount of silica, it is economical to reduce this to silicon instead of slagging it off with lime: thus obtaining a "silico-spiegel" containing both manganese and silicon. The following estimate, based on information from Messrs. Beckman and Linden, gives the cost of a long ton of silico-spiegel containing 18 per cent. silicon, 40 per cent. manganese, and 3 per cent. carbon. The ore contains 42 per cent. manganese and costs $23 per net ton.

Cost of Making One Long Ton of Silico-Spiegel With $15 Power in a Large Furnace.

Manganese ore, 2,140 lb. at $23 per net ton ..	$24 60
Silica rock, 400 lb. at $4 per net ton	80
Coke and charcoal, 1,200 lb. at $8 per net ton ..	4 80
Steel turnings, 950 lb. at $11 per gross ton	5 00
Power, 0.8 horse-power year at $15	12 00
Electrodes, 60 lb. at 7 cents per pound	4 20
Labour	8 00
Maintenance	3 00
Plant, general expense	6 00
Office, general expense	4 00
Total	$72 40

I have no figures available to compare with this, but increasing it proportionally with that for ferro-manganese, on account of the small size of the furnace, would give a total of about $85 per ton with $15 power, or $95 per ton with 0.5-cent power.

A higher-grade alloy might have the following composition:—

	Per Cent.
Manganese	59
Silicon	20
Iron	17
Aluminium	3
Carbon	1

The following is the estimated cost of making 1 long ton of this alloy, based on Beckman and Linden's figures:—

Cost of Making One Long Ton of High-Grade Silico-Manganese With $15 Power in Large Furnace.

Manganese ore, 3,200 lb. at $25 per net ton ..	$40 00
Steel turnings, 440 lb. at $10 per gross ton	2 00
Silica rock, 380 lb. at $4 per net ton	80
Coke and charcoal, 1,800 lb. at $8 per net ton..	7 20
Electrodes, 100 lb. at 7 cents per pound	7 00
Power, 0.8 horse-power year at $15	12 00
Labour	8 00
Maintenance	5 00
Supplies	1 50
Plant, general expense	3 00
Office, general expense	6 00
Total	$92 50

Increasing this total to correspond with the use of a small furnace, we get with $15 power about $100 per ton, and with 0.5-cent power about $110 per ton.

Ferro-Chromium.

The following estimate, based on the figures of Beckman and Linden, is for the production of an alloy of the following composition:—

	Per Cent.
Chromium	65
Iron	28
Carbon	5
Silicon	1

The ore is assumed to contain:—

	Per Cent.
Chromium	31 (Cr_2O_3, 45 per cent.)
Iron..............	12
Silica	12
Magnesia	16

Cost of Making One Long Ton of Ferro-Chromium With $15 Power in Large Furnace.

Chrome ore, 4,750 lb. at $36 per net ton	$ 85 50
Steel turnings, 100 lb. at $11 per gross ton ..	50
Coke and charcoal, 1,200 lb. at $8 per net ton.	4 80
Power, 1.2 horse-power years ($0.85 L.F.) at $15.	18 00
Electrodes, 100 lb. at 7 cents per pound	7 00
Labour	12 00
Maintenance......................	3 00
Supplies	2 00
Plant, general expense	10 00
Office, general expense	6 00
Total	$150 80

In a recent paper (September, 1918) R. M. Keeney discusses very fully the production of ferro-chromium, and the following notes are based on his paper: Ferro-chromium can be made of varying carbon contents, usually between 4 and 8 per cent. If chrome ores are smelted with an abundance of carbon, the recovery of chromium is good, being 90 or 95 per cent. of the amount in the ore, but the ferro will contain about 8 per cent. of carbon. If, on the other hand, the supply of carbon is restricted so as to keep the carbon below 6 per cent., the recovery of the chromium will be poor, about 70 or 75 per cent. The recovery depends partly on the richness of the ore, and when this is below 40 per cent. Cr_2O_3, the recovery is low.

American ores from California and Oregon are reported to contain as a rule from 40 to 45 per cent. Cr_2O_3. The ores from Scotty creek, in British Columbia, appear to have in some cases 40 per cent. of Cr_2O_3,

and therefore to be rather poorer than the American ores. In making 65 per cent. ferro-chrome there would be needed per long ton of the product:—

For an 8 per cent carbon product at 90 per cent recovery—5,730 lb. of ore.

For a 5 per cent carbon product at 70 per cent recovery—7,380 lb. of ore.

The power figures of Beckman and Linden are based on the statement that each pound of ferro-chromium needs 3 kilowatt-hours for its production. This may be correct with high-grade ores and in large furnaces. In Keeney's experiments, using furnaces of about 200 kw., the power-consumption was about 3.4 or 3.5 kilowatt-hours per pound, and this at 85 per cent load factor corresponds to 1.4 horse-power years.

Beckman and Linden in their original estimate state that 1,100 lb.of petroleum coke would be needed per long ton of the product, and I converted this into 1,200 lb. of coke and charcoal. Keeney used coke in his experiments, and the amount varied from 0.5 to 0.75 lb. per pound of ferro. Taking 0.6 lb. as a mean value, we find the consumption to be 1,344 lb. per long ton of the product.

For the production of ferro-chromium in a small furnace of 300 kw. it will be safer to take the more conservative figures of Keeney, and using, as before, the remaining items from Beckman and Linden, which I have already increased a little on account of the smaller scale of operation, we obtain the following estimate:—

Cost of Production of One Long Ton of 65 per cent Ferro-chromium with about 6 per cent Carbon from an Ore of 40 per cent Cr_2O_3 in a Furnace of 300 Kw.

Chrome ore, 6,000 lb. at $36 per net ton	$108.00
Steel turnings, 100 lb. at $11 per gross ton	.50
Coke, 1,350 lb. at $8 per net ton	5.40
Power, 1.4 horse-power years at $15 per horse-power year	21.00
Electrodes, 100 lb. at 7 cents per pound	7.00
Labor	12.00
Maintenance	5.00
Supplies	2.00
Plant, general expense	10.00
Office, general expense	6.00
Total	$176.90

If the power cost 0.5 cent per kilowatt-hour, the charge for this item would be:—

7,700 kilowatt-hours at 0.5 cent	$38.50
And the final cost per ton of ferro would be	194.40

Ferro-Silicon.

The following estimate is given by Messrs. Beckman and Linden for the cost of making 1 ton of the 50 per cent ferro-silicon. The output of a 300-kw. single-phase furnace would be 400 tons per annum, or 1 ton daily.

Cost of making One Ton of 50 per cent Ferro-silicon with $15 Power in a Large Furnace.

Power 1 horse-power year at $15	$15.00
Quartz, 2,400 lb. at $3.50 per net ton	4.20
Coke, 1,200 lb. at $8 per net ton	4.80
Turnings, 1,500 lb. at $10 per net ton	7.50
Electrodes, 60 lb. at 7 cents per pound	4.20
Labor	16.00
Supplies	1.50
Plant and office, general expense	5.00
Interest and depreciation, 20 per cent	10.00
Total	$68.20

If power were to cost 0.5 cent per kilowatt-hour, the power item would be $27.80, and the whole cost $81.

Prices of Ferro-Alloys.

For comparison with the figures of costs given above, I add the present and the pre-war prices of some ferro-alloys.

Ferro-manganese.—Before the war, (December, 1913), the 80 per cent alloy sold at about $50 per long ton in the Eastern States. Its present price (October, 1918), is $250 for the 70 per cent alloy, with a charge of $3.50 per unit from that basis; thus the 80 per cent alloy would bring $285 per ton, which is nearly six times its price before the war. Before the war a spiegel (low-grade ferro-manganesé) containing 20 per cent of manganese was worth $25 a ton; at present a 16 per cent spiegel is worth $75 a ton, and a 20 per cent spiegel would be worth about $90 a ton.

The price of ferro-manganese in British Columbia must be about $20 a ton higher than the above figures, so that if 80 per cent ferro-manganese could be made at $150 a to nthere would be a very good profit at present prices. On the other hand, the business would be impossible if prices were to return to their original level, unless in the meantime very important economies could be effected in the cost of supplies and other operating expenses.

Ferro-silicon.—Before the war (December, 1913), the price of 50 per cent ferro-silicon was $73 a ton, the 10 per cent alloy was $21, the 11 per cent alloy was $22, and the 12 per cent alloy $23. At the present (October, 1918), 50 per cent ferro-silicon is quoted at $160 per ton, the 9 per cent alloy is $55, the 10 per cent alloy is $57, and the 11 per cent alloy is $60 a ton. If the 50 per cent alloy can be made in British Columbia at anything like the estimated cost of $70 per ton, its manufacture should afford a good profit at present prices, and with reasonable economies should remain profitable even when prices have fallen considerably.

It will be remembered, of course, that the present market for these alloys in British Columbia is very limited, being less than a ton of each alloy daily. One reason for making ferro-alloys will be to supply them to the steel-making department of the plant, which otherwise would have to buy these alloys at excessive prices, and as the steel industry develops the outside market for the alloys will increase.

The design and cost of the plant and furnaces for making ferro-alloys have been considered in other parts of this report.

Steel-Making.

In order to be able to make pig-iron on as large a scale as possible, and also with a view to combining more profitable industries with that of iron-smelting, it is desirable to introduce into the electric-smelting plant furnaces and other appliances for making steel. The general scheme suggested is that about 25 tons of foundry iron should be produced daily for sale to iron-foundries, and a further 25 to 30 tons of white

pig iron should be made for conversion into steel in the same plant or elsewhere. The steel would probably be male in small open-hearth furnaces heated by oil, or in electric furnaces of the Heroult type. Together with 30 tons of pig-iron, about 60 tons of steel scrap could be used if desirable, thus yielding about 85 tons of steel daily. This could be used in part for making steel castings, and the remainder could be rolled into rods and bars of small section in a small rolling-mill. The manufacture and the use of steel are too well known to require any discussion in this report, and it would be impossible for me to treat the subject adequately in the space and time at my disposal. A rough estimate of the cost of a steel plant has been given in Appendix IX., and I may add the following estimate, made by Lyon and Keeney in 1915, for the cost of electric steel-making in the Western States (Trans. Amer. Electrochem. Soc., 1915, XXVIII., page 158) :—

Cost of Production of One Long Ton of Steel in the Electric Furnace in the Western States.

1.1 tons of scrap at $15 per ton	$16.50
Slag materials	1.00
Ferro-alloys	1.00
800 kilowatt-hours at 0.20 cents	1.60
Labor	2.50
Maintenance and repairs	2.40
20 lb. of electrodes at 5 cents	1.00
Amortization and depreciation at 5 per cent each	1.50
Interest at 6 per cent	.90
General	1.00
Royalty	.50
Total	$29.90

The present cost of making steel in British Columbia will be considerably higher than this estimate, on account of the higher cost of supplies and operation.

The present price (October, 1918) of steel billets in the Eastern States is about $50 per gross ton, which might correspond with about $70 in British Columbia. The price in December, 1913, was $20 to $22 in the Eastern States. There would, however, be no attempt, under normal conditions, to compete with heavy structural material, and there are many purposes for which steel can be made at a profit, under present conditions in British Columbia, even in electric furnaces using power at 0.5 cent per kilowatt-hour.

DOMINION STEEL CORPORATION REPORT FOR FISCAL YEAR, 1918.

Net earnings of the Dominion Steel Corporation for the year ended March 31st last, after deducting all operating expenses, repairs and maintenance and business profits tax, amounted to $8,768,054, as compared with $11,030,122 in the 1918 period. After all deductions, including interest on bonds and the regular dividends on the preferred shares, net profits on the year's operations amounted to $5,470,468, against $7,601,660 in 1918, and $8,221,165 the previous twelve months.

	Fiscal Years.				
	1918.	1917.	1916.	1915.	1914.
Net earnings	$8,768,054	$11,030,112	$12,967,874	$7,004,316	$3,571,058
Depreciation, etc.	1,304,322	1,384,241	1,859,595	1,192,823	920,093
Balance	$7,463,731	$9,645,870	$11,108,278	$5,811,493	$2,650,965
Interest	1,013,263	1,064,209	1,230,203	1,590,085	1,651,522
Balance	$6,450,468	$8,581,660	$9,878,075	$4,221,407	$999,443
Discount bonds	....	....	326,909	226,181	144,186
Balance	$6,450,468	$8,581,660	$9,551,165	$3,995,225	$855,256
Pref. did. (corp.)	420,000	420,000	420,000	420,000	420,000
Balance	$6,030,468	$8,161,660	$9,131,165	$3,575,225	$435,256
Pfd. div. (sub.)	560,000	560,000	560,000	560,000	210,000
Balance	$5,470,468	$7,601,660	$8,571,165	$3,015,225	$225,256
Divid. arrears	....	....	350,000	....	....
Balance	$5,470,468	$7,601,660	$8,221,165	$3,015,225	$225,256
Com. divid.	1,765,373	1,444,396	320,977	....	....
Balance	$3,705,094	$6,157,264	$7,900,188	$3,015,225	$225,256
Prev. balance	13,754,157	6,038,182	4,037,389	1,022,163	796,907
Total P. & L.	$17,459,251	$12,195,447	$11,937,577	$4,037,389	$1,022,163
Bond discount	....	....	2,899,395	....	....
Balance	$17,459,251	$12,195,447	$9,038,182	....	....
Reserves	9,500,000	....	3,000,000	....	....
Bal. forward	$7,959,251	$12,195,447	$6,038,182		....

Earnings were at the rate of 17 per cent on the outstanding common stock of the Corporation, against 23.7 per cent in 1918 and 9.4 per cent in 1916.

After deducting the disbursements to holders of the common shares from the net profits for the year, there remained to be added to the previous balance of profit and loss account the sum of $3,705,904, bringing the total up to $17,459,251. From this balance there was deducted as a reserve for contingencies, including Government taxes for the Corporation's fiscal year, the sum of $1,000,000, while the generous amount of $8,500,000 was transferred to a new general reserve fund, which is shown in the balance sheet exhibit at $11,500,000, the new reserve including the item of $3,000,000 shown in last year's statement as "Special Reserve."

The preceding table gives a comparison between the consolidated Profit & Loss Account of the Corporation—which includes the combined results of the Dominion Iron & Steel Company, the Dominion Coal Company, and the properties of the Cumberland Coal & Railway Company operated and controlled by the Corporation—for the fiscal year 1918, and the four preceding years. The fiscal year 1914, ending 31st March, 1915, covers the very depressed trade period that immediately preceded and followed the outbreak of the war with Germany, and the progressive increase of the Corporation's assets is strikingly shown.

The Balance Sheet for 1918 and 1917 compares as under:

Assets.

	1918.	1917.
Properties	$75,509,711	$68,533,446
Trustees	142,432	135,544
Inventories	9,314,602	7,853,503
Acc. rec.	5,039,479	5,335,886
War loans	1,540,101	3,617,307
Do., Employ. bal.	174,932	....
Cash	3,603,542	4,278,508
Defer. charges	585,811	493,914
Totals	$95,910,612	$90,248,111

Liabilities.

	1918.	1917.
Funded debt	$21,064,097	$21,206,777
Accs. pay.	2,702,237	2,563,827
Const. liab and taxes	2,125,693	....
Accr. int.	235,925	241,297
Dividends	568,965	576,221
Reserves	2,656,742	1,808,129
Com. stock	32,097,700	32,097,700
Pfd. stock	7,000,000	7,000,000
Pfd. subsid.	8,000,000	8,000,000
Reserve	11,500,000	3,000,000
Surplus	7,959,251	13,754,157
Totals	$95,910,612	$90,248,111

The large increase in reserve accounts, the decrease in cash and war loans, the new item "Construction liabilities and Taxes," and the increase of almost seven million dollars in property assets, are all connected with the large extensions of plant, either recently completed or now under construction, among which may be mentioned two blocks of modern coke ovens, reconstruction and enlargement of No. 1 blast furnace, new Baum coal-washery, light-oils recovery plant, and the new plate mill. Work on the last-tinued, or at least suspended until a satisfactory arrangement regarding the price of plates is made with the Government.

Although the working capital of the Corporation shows a very encouraging enlargement, quick assets showing an excess of $14,000,000 over current liabilities, the amount is not too large for the necessities of this large enterprise. Large sums of money have been spent in re-habilitation of plant and new extensions, but they were absolutely necessary to maintain the producing capacity of the steel plant, and ore mines. Further large expenditures will shortly be required to maintain the output capacity of the collieries, as owing to various reasons very little new extensions have been undertaken at the collieries during the war period.

While, therefore, earnings on the common stock of the Corporation at the rate of 17 per cent during 1918, is an encouraging feature, and the financial strength of the Corporation is greater than previously, it should not be forgotten that, notwithstanding the large amounts expended recently on capital account, further and similarly large expenditures are likely to be required in the near future, nor is it likely that the earning rate of the past three years can be maintained during the fiscal year 1919.

ARMY GAS MASKS DO NOT PROTECT AGAINST CARBON MONOXIDE.

The United States Bureau of Mines has found it necessary to issue a warning that the ordinary army gas-mask will not protect the wearer against carbon-monoxide. Certain operations around blast-furnaces have been facilitated by the use of the self-contained oxygen breathing-apparatus, where protection against carbon monoxide was required, and it should be borne in mind that the army mask, which is nothing but an air filter, is useless where the percentage of oxygen in the air is lower than required by the body mechanism, or where monoxide is present in even the smallest quantities.

FORMATION OF BASIC SLAG MANUFACTURERS' ASSOCIATION IN GREAT BRITAIN.

A Basic Slag Association has recently been formed with the object of safeguarding and promoting the interests of manufacturers. The officers are: Mr. A. W. Thomson (Alexander Cross and Sons, Ltd.), chairman; Mr. G. V. Parker (The South Wales Basic Slag Co., Ltd.), vice-chairman; and Mr. W. H. Barnett (Alfred Hickman, Ltd.), hon. treasurer. The Secretary is Mr. J. King Stewart, of 70, Benchurch Street, London, E.C. 3.

Warning is given by a Special Committee of the National Coal Association (United States) that unless the collieries are kept going by orders during the Summer a serious coal shortage will once more be experienced next winter.

The War Office "Technical Supplement" reports an occurrence of coal in Vostergotland, Sweden, having an ash content of 0.95 per cent, of which 25 per cent is vanadium. The occurrence seems remarkable, both from the point of ash content, which is very low, and the presence of vanadium therein.

According to "Metall und Erz" (abstracted by the "Technical Supplement,") Japanese manufacturers of tin-plate have contracted to deliver large quantities in August of this year to Swiss customers. The sheets are required mainly by the makers of tin containers for the preservation of food-stuffs, an important industry in Switzerland. Before the war the greater part of these sheets were imported from Germany. The price is said to be very low, namely, Fr. 1.12 per kilo f.o.b. Japanese port, equivalent to Fr. 1.45 per kilo delivered in Switzerland.

The Dorr Company, New York and Denver, has published Bulletin No. 13, describing the Dorrco Pump. This is a 16 page bulletin containing tables of dimensions, weights, capacities, etc., part lists, instructions for operating and illustrations.

HYDE & SONS TAKE ON NEW LINE.

Hyde & Sons, 43 Common Street, Montreal, have recently taken over the sales of the "Brockville Moulding Sand." This firm are well known to the readers of IRON & STEEL OF CANADA as dealers in foundry supplies and equipment of all kinds.

EDITORIAL

TENDENCIES OF WORKS OPERATION.

The future of the iron and steel trades in Canada is difficult to judge of—so far as the immediate prospect of business is concerned. As to the ultimate prosperity of the industry there is of course every ground for reasoned optimism, but there are conditions in Canada which modify the influence of the general currents of world trade. The dependence of the large steel industries in Nova Scotia on the performance of the collieries is one of these local conditions, inasmuch the ability of the steel companies in Nova Scotia to compete in the open market depends on the cost of coal, and this in its turn depends on the scale of production at the collieries, and whether the bulk of the coal produced is consumed in the processes of steel manufacture or whether the coal supplied to the steel works is only a relatively small part of the coal raised and sold. Only under the last-named condition can the minimum of production costs be reached.

At the present time the inability of the Dominion Coal Company to obtain a return of its requisitioned ships is excluding this company from the Montreal market where in years before the war it disposed of up to two million tons of coal annually. As a result, the collieries of the Dominion Company are working irregularly, and the output is perforce reduced, two things that make for high cost of production. The repercussion of this condition extends to all the coal companies, and all the steel manufacturing activities of Nova Scotia, because the output of the Dominion Company is larger than the local needs of Nova Scotia. It is not an over-statement of existing conditions to say that the chief drawback to the allied coal and steel industry of Nova Scotia at the moment is the lack of freights at reasonable prices by the Dominion Coal Company caused by the continued retention of its chartered vessels by the British authorities.

In passing it may be further remarked that the Canadian Government cannot do more than urge upon the British authorities the return of these chartered vessels, because they are all of British registry, which is a result of legislation passed some years ago excluding from Canadian coastal traffic all vessels of other than British register, without at the same time making any provision for the encouragement of a Canadian merchant marine. If the exclusion of foreign-registered vessels had been accompanied by any constructive policy of replacement by Canadian-owned ships, there would have been a valid excuse for the legislation, but as it has been it has merely served to enrich British owners and to embarrass Canadian enterprises without in any way improving the status of the Canadian mariner or increasing the Canadian merchant marine.

Apart, however, from the local influences that affect Canadian business, it may be said generally that we reflect, later in time, the business conditions prevailing in the United States. That is to say, when business prosperity is well established in the United States it is just dawning in Canada, but, on the other hand, depression has usually set in to the South before it reaches Canada.

Applying this general rule to the iron and steel trade, it would look as if a very quiet time were to be experienced in Canadian steel circles in the near future. Well-informed writers on steel matters in the United States report that the low point of pig-iron production was reached in May, and that since there has been a tendency for increase in the number of furnaces in blast. If our analogy holds true there should be an improvement in the business offering to Canadian steel plants in the Autumn, but it looks as if the remainder of the summer would see a reduction in steel and iron outputs in Canada.

Looking at the wider aspect of business, some tendencies are beginning to define themselves, among which we believe to be, a continuance of high prices for all commodities, both manufactured and raw materials and foodstuffs. Along with this will be a continuance of high wage rates, which is a natural accompaniment of decreased purchasing value of money, and with it will go, what appears to be an equally natural accompaniment, the shortening of working hours and the decreased efficiency of workmen during the working hours, particularly men working on a contract basis. We believe this arises partly from some confusion in the mind of the worker as to the extent of his wages. They look large, notwithstanding the increased cost of commodities, and the spur to increased production is not so pronounced as in the days of smaller wages.

The stoppage of European emigration to America during the war has lessened the supply of unskilled labour, and to what extent Europeans have gone home since the Armistice was signed we do not know, but it is generally agreed that when peace finally comes to Europe that a large efflux of fairly well-to-do European laborers will take place from America to Europe.

Simultaneously it is expected that a large influx of British-born emigrants, including many demobilized soldiers will come to Canada, and these men are not the class from which in the past the unskilled labour ranks of America and Canada have been recruited. A shortage of unskilled labour appears therefore to be a probability of the near future.

The tendency to reduce the hours of labour is general, and industry must adapt itself to the new conditions so that production will not suffer. This may lead to radical alterations in the organization of industries where the processes of manufacture are continuous, as in iron and steel works.

In other industries which have been operated on a "one-turn" basis, the shortening of hours to eight, seven and even six hours per day, must necessarily lead to multiplication of turns in the twenty-four hours, if production is to be maintained. This is particularly true of coal mines, where the restriction of the working hours to eight productive hours out of the twenty-four hours of the day, is a waste of capital expenditure, see-

ing that two or three times the working territory and mine equipment must be provided to produce the output from a property operated on a one-turn basis that could be produced from a smaller property operated on a double or triple-shift basis.

A probable result of shorter hours of labour will be an increase in the number of daily turns, and a speeding up of production during the turns.

As a result of the combined operation of a shortage of unskilled labour, of the disinclination of the available worker for hard and monotonous manual work, and the effect of shorter hours of labour, we may anticipate a greatly extended use of mechanical appliances in substitution for manual labour, particularly in such operations as shovelling coal and ore, and in the handling of heavy materials generally.

Money invested in labor-saving mechanical devices at this time will, we believe, be expended to good advantage.

WORKMEN'S COMPENSATION IN ONTARIO.

The Report of the Ontario Workmen's Compensation Board for 1918 shows a total revenue, including the provisional balances carried forward from 1917, of $4,-319,439.98, and expenditure within the 1918 period of $3,474,769.09, carrying forward to 1919 $844,670.89.

The cost of administration was 1.55 per cent of the assessments received, but this figure is not quite representative of the actual cost, because out of $152,335.82 expended in administration, the Province contributed $100,000.00, in addition to paying the salaries of the Commissioners and providing the office accommodation. But had the assessment revenue been called upon to meet the whole of the administration expense it would have been a moderate charge. The cost of administration in Nova Scotia, excluding the salaries of the Commissioners, was, in 1918, 3.85 per cent of the assessments.

It is difficult to estimate what proportion of the figures given in the Report applies to the iron and steel industry, but if we add together the figures for "Rolling Mills, etc. (Class 8a), Foundries, etc. (Class 8b), Fabrication Structural Steel, etc. (Class 8c), Metal Articles (Class 10), and Steel Construction (Class 32), we may gather the following comparisons. When compared with all the classes within the assessment basis of Schedule One, we find that the metal workers numbered 29.4 per cent of all the trades, and earned 34.6 per cent of the total wages paid. The revenue received by the Board for the metal trades totalled 36.4 per cent of the aggregate assessment revenue from all classes, and the expenditure made by the Board on account of the metal trades called for 39.8 per cent of the outlay for all classes.

These figures are to some extent vitiated for comparison because munition plants controlled by the Imperial Munitions Board come under Schedule 2, under which the employers are individually liable for compensation to injured workmen, and are not dealt with under the system of collective assessment as in the Schedule One classes.

The cost for medical aid amounted to 14 per cent of the amount of compensation awarded under Schedule One. The provision of medical aid for 30 days after the date of accident is a new provision in the Nova Scotia Workmen's Compensation Act under an amendment passed at the last sitting of the Houses of Assembly. It is interesting in this connection to note that under a recent amendment to the Ontario Act the limitation of one month has been removed from the medical aid provisions.

The Report refers to complaints made by some members of the legal profession that they are ruled out of practice in connection with claims by the operation of the Act, on which the Board unfeelingly comments that this is "in accordance with the spirit and intention of the Act."

If the rectitude of the principle of workmen's compensation is once admitted, we believe the method of administration by a Board, through collective assessments, is the best method. Among the advantages thereby secured we may quote from the concluding portion of the Report itself those of "limitation of payment by the employer as nearly as possible to what actually goes to the workman, and elimination of litigation with its annoyance and expense," both of which we believe are secondary to the limitation of the employers' liability to an amount which by the system of collective liability can be calculated as a percentage upon the pay-roll, varying within the small limits of the mass average. This limitation of the individual employer's liability is particularly desirous in occupations exposed to a disaster risk, where the verdict of a jury may have serious consequences for the employer.

"THE FORMULA FOR ORDER IN GOVERNMENT."

The Chairman of the Federal Trade Commission of the United States, speaking before the National Wholesale Grocers' Association at Cincinnati, Ohio, is reported in the "American Metal Market" in part, as follows:

"It is no idle thing to say that the United States is "today the leader of the world, for we have become the "the Keeper of the Seals. We have the formula for "order in Government. We have almost a monopoly of "accessible raw materials, and the chief control of cre-"dit. The world must come to us therefore for order, "raw material and money. We must give bountifully. "The world cannot do without us. As we gave the idea "of democracy to the world, so in the hour of the uni-"sal birth of republics, the United States must extend "a helping hand to every struggling people."

The idea behind Mr. Colver's remarks, as is evident from the remainder of his speech, is excellent and praiseworthy, being in short that the United States must bear its share of world responsibility, but his leading assumptions are incorrect.

The possession of wealth and raw materials in abundance has been given to the United States, but no spiritual merit resides in material prosperity. The greatness of a nation consists in other and less tangible possessions, and amongst them we are not disposed to class the exclusive possession of "the formula for order in Government."

The despair and internal anarchy of Russia and the adjoining portions of Central Europe are the result of the bitterness of defeat, of hunger, disease and death in every conceivable form. Such things have happened before, and nations have arisen from abysses of despair and defeat and have worked out "the formula for or-

der in government" by a toilsome process of trial and experiment, the only method by which lasting progress and happiness can come to man.

No nation can be said to have found the secret of order until it has gone through the fires of testing, and while no one would seek to minimise the material effort of the United States in the war, nor could fail to appreciate the unselfish and spiritual motives that impelled our Ally to fight alongside our armies, it cannot be said that the United States has been tested by suffering as was France and Britain. It is not necessary to quote figures to prove this statement. Who that has watched the effort of France's citizen armies, and the bravery of her civilians, or has appreciated only a part of the inward siginificance of that modern miracle, the response of the British peoples to the call to arms, can doubt that there are other, and older democracies that have worked out the problem and found a fairly workable formula of government.

Neither can we assent to the statement that the United States gave the idea of democracy to the world. The democratic institutions that were worked out in the United States were transplanted from England, where the rights of the people were catalogued and signed by the King in 1215, and where the theory of the divine right of kings was smashed, so far so as Englishmen were concerned, in 1649. The roots of our democracy go back further than this, nor, if the principles are analysed, is there much difference betwen the Witenagemote and the City Council of Cincinnati, Ohio.

The people of Canada are not prepared to concede either the statement that our formula of order in government is inferior to that of the United States of America, or that we learned our ideas of democracy from that great kindred nation. The roots of nationhood of Canada and the United States grow from the same ancient soil, and about the only difference between us is that the population of the United States is some twelve times larger than our own.

BRITISH IRON-ORE RESOURCES.

We reproduce in this issue a note on British iron-ore resources by Professor Henry Louis, taken from "Nature," and also, in part, a paper read before the West of Scotland Iron & Steel Institute on the available basic iron ore supplies for the Scottish iron industry, by H. Arnold Wilson.

Mr. Wilson's article has interesting references to the Wabana iron-ore mines, and their possibilities as a source of supply for the Scottish iron industry. His auditors must have been struck with the details given as to the time occupied in loading the large ore-carriers of the Nova Scotia Steel & Coal Company at Wabana, and the time of discharging at North Sydney. Particulars are also given of the discharging time at Emden and Rotterdam and in Philadelphia, and Mr. Wilson correctly states that if ore is to be attracted to Scotland an enormous improvement must take place in the despatch given to steamers.

In view of the fact that the Wabana deposit is entirely controlled by the Nova Scotia Steel & Coal Company and the Dominion Steel Company, Mr. Wilson's comment is encouraging to the shareholders of these two leading Canadian steel companies, when he states "it is doubtful if there exists in the world any deposit that so combines the advantages of good ore, easy mining, excellent location and cheap transportation."

In view of the phosphorus content of the Wabana ores, Professor Louis's reference to the abandonment by the Board of Agriculture "of the so-called citric acid test for basic slag in favour of its valuation by the total phosphoric acid present" has a distinct bearing on the operations of the steel companies in Nova Scotia, and in this connection it may be noted that the basic slag fertilizer manufacturers in Great Britain have formed an association for mutual protection.

As bearing on the proposal that a bounty should be paid on native iron-ores smelted in Canadian furnaces, the action of the British Government during the war is of interest. Owing to the difficulty of obtaining supplies of ore from Spain and other overseas sources, attention was turned to the phosphoric ores of Lincolnshire and Oxfordshire, and to encourage production the Ministry of Munitions defrayed the cost of excavating plant and mechanical appliances to the extent of one-third of cost. The result was to demonstrate that the United Kingdom was possessed of more important iron ore resources than had been generally supposed. Similarly in Canada, we require either the spur of necessity or possible gain to bring about the development of our own iron-ore resources. We have them, there is no doubt about that, but if we do not use them we might just as well be without them, if we desire the steel industry to be a self-sustaining thoroughly Canadian enterprise.

"THE CANADIAN FERTILIZER."

We welcome the "Canadian Fertilizer," the latest addition to the growing list of Canadian technical publications, and consider the time was opportune for its appearance.

The iron and steel industry is vitally interested in the market for fertilizers, inasmuch as ground basic-slag and ammonium-sulphate are two principal by-products of iron and steel manufacture. As instancing the enormous market which awaits the awakening of agriculturists to the value of artificial fertilizers, "Canadian Fertilizer" states:

"In the year before the war, Germany used 6,500,000 tons of fertilizer on German lands. About ten years ago the United States used a few hundred thousand tons per year; now the farmers, fruit-growers and gardeners of the United States use a total of about 7,500,000 tons per year, having already passed Germany in this respect. Canada is just beginning to wake up to the need of soil improvement. The present consumption in Ontario is estimated at about 40,000 tons a year and the consumption of the Dominion may not exceed a hundred thousand tons. In all probability it will be doubled next year."

The production of sulphate of ammonia as a by-product of the carbonization of bituminous coal is only in its initial stages in Canada, but the growing need of Canadian agricultural lands for fertilizers will, we believe, outstrip the available supply more or less indefinitely.

Up to now, a large portion of the sulphate of ammonia manufactured in Nova Scotia has been exported to the West Indies for sugar culture, and very little indeed has been used in Canada, nor has any real attempt been made to create a Canadian market for this fertilizer under its proper name. Sulphate of ammonia is a main ingredient of the "plant foods" and composite fertilizers sold by retailers to the small gardener, but

the general public is very ignorant of the value and the proper method of using this potent stimulant of the growth of root crops, particularly those containing sugar. An aggressive sales policy, combined with the preparation of sulphate for the market in an attractive and easily usable form, and the dissemination of educational literature could speedily create a good market for sulphate as a general garden fertilizer throughout Canada.

The sale of ground basic-slag we understand has hitherto been limited by the quantity of slag available and the capacity of the grinding mills. Its value is fully appreciated by Canadian farmers, but the market has never yet been satisfied.

As some indication of the waste of fertilizing material it may be pointed out that there are only two or, at the outside, three operating gas companies in Nova Scotia, and that with this exception, and the coal coked in the by-products ovens of the Dominion Steel Company at Sydney—roughly 800,000 tons per year, the whole of the soft-coal production of Nova Scotia, which is now a little over five million tons annually, but should normally be seven millions, is consumed without recovery of the by-products.

The fertilizer market awaits the enterprise of the allied coal and steel industries, but there are notable competitors and various successful processes for the fixation of nitrogen which it should be the endeavour of the existing industries to forestall.

The first issue of "Canadian Fertilizer" should be seen by all whose business in any way concerns the production and sale of fertilizers, as the articles are by prominent scientific agriculturist, such as Dr. Frank Shutt of the Dominion Experimental Farm at Ottawa, and Prof. H. G. Bell of the Soil and Crop Improvement Bureau.

"Canadian Fertilizer" is issued by the Biggar Press, Ltd., of Toronto, who are also publishers of the Canadian Chemical Journal.

C. P. R. FLEET TO BE UNDER CANADIAN REGISTER.

The following excerpt from "Shipping" of New York has an interesting bearing on the difficulties under which the Dominion Steel Corporation is placed by having its vessels under British register at this time, and indicates that the formation of a Canadian mercantile marine may arise from the disabilities incident to British register, which is a curious reversal of the intent of those who insisted some years ago on the exclusion of vessels having foreign register from Canadian coastal waters trading. The British register of Canadian chartered vessels made it possible during the war for the British Admiralty to requisition these vessels, which from the standpoint of Imperial defence, was a good thing during a time of such necessity as we have passed through, but now that the war is over, it would seem as if the British authorities were pressing their advantage unduly, and Canadian shipowners are being forced to apply for Canadian register in self-defence.

"Shipping" remarks: "What is hoped may prove the foundation of a Canadian mercantile marine, is the application by the Canadian Pacific Railway Co. for the transfer of its ships to Canadian Registry. The rumor of such a step has been current in shipping circles for some time. What it desires is the same privileges under Canadian registry as it at present enjoys under English registry, and there appears no reason why it should be unable to receive them. Chairman Bosworth of the C.P.O.S., has sailed for Canada to discuss the matter with the head office of the company. Canada, if it is ever to attain its status as a great nation, must develop its shipping facilities and ultimately have a merchant marine of its own. If the Canadian Pacific takes the first step, it is hoped others will follow. It is of course the only purely Canadian company involved, and if any of the other steamship concerns decided to follow suit, a division of their fleets between English and Canadian registry would be necessary. However, there are all sorts of possibilities in the shipping world and the organization of a new company which aims to handle Canadian trade is not the least of them. Among the advantages which would accrue to the Canadian Pacific under Canadian registry would be better control of their shipping space, fifty per cent of which is still used by the British Ministry of Shipping."

THE FIRST NON-STOP ATLANTIC FLIGHT.

British citizens would not be human if they did not, all the world over, feel elated and proud at hearing of the flight of Alcock and Brown from Newfoundland to Ireland in a Vickers machine. That we live in deeds and not in hours is acknowledged by all men today in the strange sense of remoteness that we experience when we think of the days before the war. Much, very much of mankind's total experience has been packed into the past five years, and we are today reaping the fruits of such labour, such daring and self-sacrifice, such co-operative and combined effort of scientific research, as was never in history compacted into so small a span of time.

The record of the wartime experiences of the two men who have actually done a thing that is new under the sun, is sufficient proof that their success in crossing the North Atlantic was no fortuitous happening, but was the outcome of long endeavour and trial.

The flight has especial interest for steel makers, inasmuch as it was made in a Vickers machine, and therefore has behind it the long traditions of the Sheffield artisan in steel, and the machine is stated to have contained an unusual amount of steel in its frame. It would seem probable that steel, or some form of steel alloy, will play an ever-increasing part in the construction of flying machines, particularly as they evolve into vehicles for the conveyance of passengers. The mechanical properties of steel, and in especial its non-inflammability, must eventually occasion the use of steel, or steel alloys, to supersede the use of wood and fabric in the construction of flying machines for passenger conveyance.

THE SHIP-PLATE MILL AT SYDNEY, N.S.

In the Report of the President of the Dominion Steel Corporation to the shareholders it was stated that:—"Some time after the close of the company's fiscal year, the Minister of Marine intimated that it would be necessary to consider some alteration in the arrangements existing between the government and the Steel Company in respect to ship plates, and that work upon the mill should be suspended while the matter was under consideration. Work was accordingly stopped, but al-

though some preliminary discussions have followed, nothing definite has been proposed. Your directors are assured that, whatever may be the ultimate decision of the government, it will not result in any loss to the company.''

Simultaneously with its synopsis of the Dominion Steel Corporation's annual statement, the ''Monetary Times'' published the following paragraph:

''The Hon. C. C. Ballantyne and Vice-President Perley, of the United States Steel Corp., had an interview last week at Ottawa, the outcome of which may prove to be favorable to the American company. It is understood that failing a satisfactory outcome of negotiations between the government and the Dominion Steel Company for a modification of the contract for the steel plates for shipbuilding, an arrangement may be made with the United States Steel to furnish the supply from Ojibway.''

On the face of it, the juxtaposition of these two announcements would indicate that the Federal Governments was playing off the United States Steel Corporation against the Dominion Steel Corporation, and viewed in the light of the relative strength of these companies, and the geographical position of their respective plants, so far as shipbuilding on the Great Lakes is concerned, the Sydney concern is at a considerable disadvantage.

The question of the Sydney plate-mill cannot however be viewed from a strict standpoint of commercial competition. The erection of a plate-mill at Sydney was urged upon the Dominion Steel Corporation by the Federal Government at a time when the submarine menace was at its worst, and when the need for ships was paramount. It would have been a very proper proceeding on the part of Ottawa to have furnished all the capital needed for the erection of a plate-mill, but this expenditure was undertaken by the Dominion Steel Corporation. Nevertheless, the erection and future operation of a ship-plate mill in Sydney, cannot be regarded as purely a private enterprise, and the price at which the Government undertook to purchase plates when the mill was in operation was sufficiently large to amount to a subsidy of an industry, urgently needed for national progress and protection, but not demonstrated to be justified as a private commercial enterprise.

Students of the growth of national importance and wealth know that it is associated with the possession of coal and iron resources combined with a maritime location, a sea-faring population and command of the seas, all of which essential considerations may be found conjoined in Nova Scotia.

Shipbuilding is an ancient tradition of Nova Scotia. Today the Nova Scotia Steel Company is established as a builder of steel ships, and as a maker of ship machinery and marine forgings of the heaviest kind. Halifax has a shipbuilding plant under construction, and if Canada has not awakened to the national importance of Halifax as the eastern terminl of Canadian transportation, other nations have. Under all the circumstances a steel ship-building industry should remain as a permanent record of our war effort on the Atlantic coast, and the people of Nova Scotia will find it difficult to believe that having put its hand to the plough the Federal Government is going to turn back.

As we go to press, it is announced that the negotiations between the Minister of Marine & Fisheries and the representatives of the Dominion Steel Corporation have resulted in a satisfactory agreement, and the construction of the plate-mill at Sydney, which in the interim has been suspended ,will now be resumed. When particulars of the arrangement transpire it will probably be found that the price at which the Government consents to purchase the plates rolled by the Sydney mill is higher than competitive bids from the United States, but, if the encouragement of Canadian shipbuilding is the intention of the Government, as presumably it is, then the local limitations must be accepted as part of the arrangement. Not the least of these limitations is the increased cost of coal production in Nova Scotia, and while the Government is fully justified in fostering a ship-plate industry in a locality so eminently suited for it as Sydnew, there is a limit to the extent to which government assistance can be extended. If the coal-miners insist upon creating such an economic embarrassment as a thirty hours week, no amount of state aid will avail to perpetuate the industry. No juggling with wages or with profits will permanently enable the people of any country to enjoy or consume a greater value than that of their production.

PERSONALS.

W. Walshaw, who has for the past six years been in charge of the 16 inch mill of the Dominion Steel Company at Sydney, has returned to England.

Frank L. Estep, formerly chief engineer of the Tennessee Coal, Iron & Ry Co., and up to within about nine months ago chief engineer of the Nova Scotia Steel & Coal Company, has joined the firm of Perin & Marshall, consulting engineers of New York.

Mr. H. J. McCann, purchasing agent of the Dominion Iron & Steel Company, at Sydney, has been appointed assistant to the president of the Dominion Steel Corporation in the Montreal office. Mr. McCann has been connected with the Steel Corporation for approaching twenty years. Since 1911 he has held the position of purchasing agent, previously to which he was for some five years superintendent of the retail stores of the Dominion Coal Company. Mr. McCann's qualifications for his new position include a comprehensive knowledge of the operations of both the coal and steel portions of the activities of the Corporation.

FOREIGNERS SAILING FROM NEW YORK.

New York, June 24.—The largest number of aliens leaving this port on any one day since 1914 sailed yesterday, according to information received at the United States Customs House.

The following table will show how the number of departures has grown since December:

	Total leaving.	Daily average.
December	10,000	384
January	13,278	491
February	16,854	674
March	21,774	837
April	23,773	914
May	26,812	993

Thus far the average for every day in June has been considerably over 1,000.

The Iron and Coal Industry in Nova Scotia

A Paper read before the Montreal Metallurgical Association, by F. W. Gray.

A distinctive feature of the iron and coal industries in Nova Scotia is that each of the two large companies there is self-contained, being in each instance the owners and operators of iron ore deposits, of coal deposits, and of railways and shipping fleets.

The genesis of both companies, namely the Nova Scotia Steel & Coal Company and the Dominion Steel Corporation, came about through the presence of metallurgical coal deposits near a commodious and accessible harbour, and the comparative proximity of the Wabana iron ore deposits.

During 1913 the steel trade was at a low ebb, and during 1914, and the early part of 1915, the steel business was so small and so unremunerative, that the survival of the industry was almost in question. Had the steel industry stood alone in these years it would have fared badly, but allied with the coal industry a certain amount of earning power was possible.

When war came an opportunity was afforded the steel companies to show what they were capable of in production.

The Nova Scotia Steel Company was a pioneer in demonstrating the possibilities of Canadian plants as makers of shells from basic process steel. Shells, ranging from the 18 lb. shrapnel to the 9.2 shell, were forged, machined and assembled ready for loading with the explosive. Later, the manufacture of the assembled shell was largely given up, and the plant confined itself to the forging of the shell cases.

The Dominion Steel Company did not enter upon the manufacture of shells further than the furnishing of blanks for shell forgings, and the rolling of shell steel suitable for ranges from 4.5 to 8 inch shells. Very large quantities of shell steel were rolled by this company.

In addition, the Dominion Steel Company erected a plant for the manufacture of toluol from coke-oven gases, which was later enlarged so that at one time this company was producing about 600 gallons of toluol daily. Large quantities of wire was supplied by this company to the Allies for use in entanglements, and also quantities of nails for trench uses.

Both steel companies have increased their plant equipment during the war period, but, with the exception of the toluol plant at Sydney, no increase in production during the war period was obtained from the new equipment, as it was undertaken too late to be of service during the actual war period. Had the war continued, however, the steel companies would have been in a position to materially increase production.

The additions to the plant of the Dominion Steel Company include a new coke-oven plant, without doubt one of the finest by-product coke plants in America. It consists of two batteries of ovens, of the Kopper's type, with plant for the recovery of sulphate of ammonia and tar. A plant for dealing with the light oils is also being provided. The arrangements for pushing out the coke and for quenching include the most complete labor-saving devices and are designed to give a large strong coke, free of black ends and excessive moisture.

The feature of these modern ovens is the narrow coking chamber and the short coking period. Good results are being obtained from the sulphate of ammonia plant, the yield of sulphate running about 35 lbs. per ton of coal coked, and being dry and of a good white colour.

As part of its improved coking equipment, the Steel Company has also installed a Baum coal-washer, designed to give a washed coal with low moisture content. A washery of this type is operated by the Dominion Coal Company, and another washer, also of this type, was installed during the war by the Nova Scotia Steel Co. at Sydney Mines.

No. 1 Furnace of the Sydney plant was also reconstructed and enlarged, and with a new washer, new ovens and new blast-furnace the Dominion Company should be in a position to produce record quantities of ingot steel. The limit to production of this company is now in the open hearth, which will no doubt be remodelled and enlarged shortly.

The Scotia Company did not undertake any new construction beyond providing a spare blast furnace to ensure the continuity of production whenever it became necessary to shut down the operating blast furnace for re-lining. This furnace has now been in blast between five and six years without relining.

Generally speaking the equipment of the steel companies in Nova Scotia is larger and more modern than at any previous time, and no large amount of machinery is rendered useless by the cessation of war work, because in the case of the Dominion Company, no new plant was required for shell steel, except machinery for cutting shell blanks; and in the case of the Scotia Company, the later processes of shell manufacture having been discontinued some time before the close of the war, no particular readjustment of equipment was required to resume ordinary business, and surplus equipment had been disposed of in the meantime.

Two permanent additions to the steel industry will, it may be hoped, remain from the war period, namely the building of steel ships by the Scotia Company at New Glasgow, and the manufacture of ship-plates in Sydney by the plate-mill in process of construction. The fate of the plate-mill, however, lies in the hands of the Government. Although this mill is being erected by the capital of the Dominion Steel Company, the contract given by the Government for plates amounted to a practical subsidy of a ship-plate industry in Sydney. It is understood that all work on the construction of this plate-mill is suspended, and that the Dominion Steel Company is endeavoring to cancel contracts made for erection and provision of mill parts, but it hardly seems possible that having put its hand to the work the Government should turn back, unless it should be that those who direct the policy of the Government have no faith in a future shipbuilding industry in Canada, and look upon its recent progress merely as a war effort. This we can hardly believe. On a strictly commercial basis, however, a ship-plate mill in Sydney can hardly be a success unless the Government buys plates at higher prices than they can be obtained for elsewhere.

The basis of the steel industry is the coal industry, and it is the cost of the coal supply which will determine whether the steel industry in Nova Scotia can thrive

or not. Unfortunately, coal costs are higher than they ever have been in Nova Scotia, nor is there any reasonable prospect that the cost of coal production will decline as rapidly as it rose, or will ever go back to what it was before the war.

There are a number of reasons for the increase in coal costs. Some of these reasons are of a temporary influence, and may be expected to pass away, more or less.

The most important reasons is the shortage of suitable labor occasioned by enlistments of mineers. The voluntary enlistment of miners was of a most discriminating kind. It took the best men, the young men, the producers, and it left the poorer men, the older men and the non-producers. The effect was to reduce the output without proportionately reducing the number of men on the pay-roll, in fact, in some instances the total number of employees was increased for a much smaller output. This condition has never been righted, and although the men are gradually coming back to the mines, the working forces cannot for years to come be as efficient as they were before the war took away the best men. It is not necessary to say that many of these men will never come back, because the casualties among the Nova Scotian regiments were heavy. Nevertheless, the labor situation is one that will admit of some amelioration. A shortage of unskilled labor may be experienced for an uncertain period in the near future.

The increase in wages is another potent cause for increased cost of mining. How much of this will pass away, or how soon, no one can say, A permanently increased wage scale is at least probable.

Other causes for increased mining costs are physical. The Nova Scotian coalfield is no longer young The best and most cheaply accessible seams are to a large extent mined out. The percentage of coal now being extracted from submarine areas is about 70 per cent. for the whole of Nova Scotia and over 80 per cent. for Cape Breton Island. A submarine mining proposition is one of cumulative costs, because the workings are always getting further away from the sources of power and ventilation, and as the haulage distances increase the efficiency of the workmen at the coal faces decreases because it takes longer to go to work and return to the surface.

Other increases in coal costs arise from increased municipal and provincial taxation, new federal imposts, new expenditures in such matters as workmen's compensation, all doubtless very necessary and unavoidable, but all nevertheless adding to the cost of coal.

The only way in which these increasing tendencies in coal cost can be met is by large capital expenditures on plant, the introduction of double and treble shift systems—because in these days of shorter hours of work, a single shift of eight hours out of every twenty-four is not a proper utilization of the capital expenditure on a colliery. Production must be intensive, and every working hour must be utilized.

With the best engineering skill and the most capable organization, however, it is certain that the days of cheap coal — if they ever really existed — are gone.

A great deal of the present high cost of coal is due to improper book-keeping methods in the past, for the cost of coal production and the profits on its sale were calculated on the bare costs of labor and material, without provision for future liabilities, and in many cases profits were calculated that were never earned and coal was sold for less than it actually cost in mine—only those who sold it did not know it.

The outlook for the steel business in Nova Scotia seeing that it is based on coal costs, would therefore be gloomy, if it were not that similar causes are operating to raise coal costs in the United States and in Britain.

A notable and growing asset of the Nova Scotia steel companies is the possession of the Wabana iron-ore field. There has always been a great deal of scepticism regarding the value of the Wabana deposit, and the value placed upon them by the companies who control the ore-field has usually been regarded as exaggerated, and arising from a desire to increase bond and stock prices. The deposit is largely submarine, but so far as can be judged the limit to the quantity that can be taken out will be found in the physical limitations of distance from shore, and not in the limitation of the extent of the ore-body itself.

The potential importance of Wabana first attracted the attention of a wider circle than those immediately interested in it about the start of the war when the Dominion Royal Commission visited St. John's, Newfoundland, and since that time British interests have taken much notice of Wabana and its importance as a source of ore-supply for the British Empire.

Very recently a paper was read before the Iron & Steel Institute of Scotland in which Wabana was described as being a probable main supply for the West of Scotland iron trade. (See page — of this issue.)

The possession of the Wabana deposits gives added stability to the Nova Scotian steel enterprises, because by the sale of ore to outside parties, a revenue can be obtained that may serve to bridge periods of low earning capacity in the business of steel manufacture proper, and it may be stated that this source of revenue has been very little drawn upon by even the Scotia Company — which has been for some time a seller of ore — and by the Dominion Steel Company not at all. (Since the foregoing was written the Dominion Steel Corporation has announced its readiness to sell ore in large quantities.)

The submarine mining operations of the two companies at Wabana have much in common. Under an arrangement made some years ago the Scotia Company has turned over to the Dominion company one of its slopes, which the Dominion people are now operating. The Scotia Company in the interim has driven two tunnels to sea over two miles in length, which have tapped and are now working in the main ore-body of the Scotia Company's areas lying outside of the areas of the Dominion Company. The ore has been extensively proved to be of good quality, varying in thickness from 17 feet to 30 feet.

The surface equipment of both companies has been recently much enlarged, that of the Scotia Company at its new tunnels being quite new. The plants are in keeping with the magnitude of the undersea development, but it may be expected that the surface developments and power equipment will be still further added to from time to time as the demand for ore requires. So far as can be determined there is no limit to the output of ore except the number and capacity of the openings from shore and the extent of the haulage equipment.

The Wabana ore-field may be definitely stated to be in a position to produce all the ore for which a market exists, and that at a moderate cost.

The loading and unloading arrangements of the two steel companies and the type of vessel used to carry the ore between Sydney and Newfoundland have been developed to great perfection, and it only needs the development of discharging equipment of similar efficiency in Britain to enable Wabana ore to enter that market as a serious competitor of other ores.

The somewhat high phosphorous content of Wabana ores, which added to the cost of producing steel, is not altogether an unmixed evil, as it yields a slag with a high percentage of phosphoric acid, for which a large market has already been created in Canada and in the West Indies, where also a large part of the sulphate of ammonia manufactured at the Sydney plant is sent and used in the sugar industry.

As to the future of the steel business in Nova Scotia, no one can make accurate predictions because the necessary data is not available. The outstanding fact is that the steel companies are financially in a stronger position than ever before in their history, and they have good reserves of quick assets. The plant is also large and more modern than ever before, and the variety of products manufactured is greater, which gives a flexibility to the business that is very desirable.

The operating conditions of both companies, when they recover from the upsetting effect of war-time, are more efficient and thereby more economical than ever before, and it may be that some economies can be effected to offset the high cost of fuel. The Dominion Steel Company has recently appointed one of its officials to the position of "Economy Engineer," which indicates a realization that some economies are possible, although it must be admitted that in the utilization of by-products the Nova Scotian steel companies have never been backward, even when the cost of fuel was not such a spur as it is likely to prove to-day.

As to the labor supply, it is evident to all who observed the trend of events in other parts of Canada and in the world at large that the steel workers of Nova Scotia played an admirable part during the war. With the exception of some relatively minor troubles there was no general stoppage of work in either the steel or coal industries during the war period, and all parties seemed to realize how much depended upon their exertions. The train-loads of material that left Sydney and New Glasgow were so visibly munitions of war that the workers felt themselves one with the soldiers in the trenches. The large convoys of "dazzle-painted" ships that weekly gathered in Sydney Harbor, and the presence of sailors of every allied nationality, the glimpses of the naval patrol that were to be caught from the cliffs and shores near the coal mines, together with the presence on the firing line or on their way there of thousands of miners and steel workers, were the accompaniments of a spirit of compromise and steady work that will ever remain a refreshing memory of the same patriotism of the Nova Scotia miners and steel workers.

Some wild, uneconomic and revolutionary sentiments are reported in the newspapers as coming from Nova Scotian industrial centres just now, and there is much talk of unreasonable reduction of the hours of labor. Herein lies probably the greatest economic danger of the present time. Rates of wages are relative, and in these days of depreciated currency we can hardly tell whether a given labor rate or salary is high or low, because we do not really know what the value of money is or in what it consists to-day. But hours of labor, other things being equal, are the measure of production, and while some increase of the rate of production is possible within reasonable hours of labor when compared with unreasonable and fatiguing hours of labor, no intensity of production will enable the steel industry of Nova Scotia to live if the miners for example were to reach what is stated to be their goal, namely, six hours per day for five days a week. Under these circumstances the miner would soon learn that no employment at all was coming his way.

From the past record of Nova Scotian workmen one can trust in their sanity and their sense of economic possibilities, but it may well be that some of these economic experiments will have to be tried out before the realization of their unworkability in Nova Scotia will be admitted.

CONTINUED DECLINE IN NOVA SCOTIA COAL PRODUCTION.

Indications are that the coal production in Nova Scotia will this year not reach five million tons.

The trend of coal production in Nova Scotia may be discerned from the following table of annual production:

	Gross Tons.
1913	7,263,485
1914	6,650,031
1915	6,709,951
1916	6,171,424
1917	5,649,188
1918 (about)	5,220,000
1919 (estimated)	4,850,000

If the estimated production of 4,850,000 tons in 1919 is not exceeded—and there is not much reason to believe that it will be—it will be necessary to go back to 1902 to find so small a production. The loss in royalty revenues to the Province of Nova Scotia between the possible output of the collieries on the basis of 1913, and present annual production, exceeds $300,000 per year.

The Dominion Coal Company's Cape Breton collieries show the heaviest decline during the first half of 1919 as compared with the first half of 1918. This is chiefly due to the refusal of the British Admiralty to release the chartered vessels of the Dominion Coal Company which were requisitioned during the war. Until these vessels are returned the St. Lawrence ports are closed to Cape Breton coal, which before the war, and for the years 1914 and 1915 approached two million tons annually.

DR. RUTTAN TO VISIT LONDON.

Dr. R. F. Ruttan, of the Department of Chemistry, McGill University, left Montreal June 28th for England and Brussels. He is going as representative of the chemists of Canada to the Inter-Allied Federation of Chemists, which meets in London, and will also represent Canada in the International Research Council which meets in Brussels, July 18 to 28. Dr. Ruttan expects to be home about the last week in August.

Company Notes

ALGOMA STEEL COMPANY TO MAKE STRUCTURAL STEEL.

Further extensions in the Canadian steel industry are announced in a decision just made by the Lake Superior Corporation to begin work immediately on an extension of the rail mill of the Algoma Steel Company's plant, at Sault Ste. Marie. The purpose of the extension is to make possible the production of structural steel up to 23 inches. Work will be begun at once, and extension will cost several hundred thousand dollars. It is expected to be completed by November. It was stated today that this is but the first step in a considerable development of the plant with a view to further caring for the Canadian market for this form of steel product, and that the ultimate scheme will be on a large scale.

The present extension is not made with any understanding with the Dominion Government, but is said to be based on the expectations of the market for Canadian produced steel, which is expected to extend on a large scale.

The rail mill of the Algoma Steel Company is now running at about 46 per cent capacity, and the other portions of the steel plant are going at about full capacity.

NOVA SCOTIA STEEL & COAL COMPANY AND ITS SUBSIDIARIES.

Meetings of the directorate of the Nova Scotia Steel & Coal Company and its subsidiaries were held in Montreal on the 17th June, when the regular dividends on the preferred and common stock were declared for the quarter ending 30th June.

The Board authorized the directors of the Eastern Car Company, a subsidiary, to pay on July 15th next a year's dividend at the rate of six per cent for the year ending 31st December, 1918, thus wiping out all arrears on the preferred stock of the Eastern Car Company.

The management reported the successful completion of the work connected with the new submarine slopes at Wabana and made reference to the new mechanical loaders now being used underground which are being found of great utility in increasing output and decreasing the cost of loading the ore underground.

Two steel ships are being built at Trenton to the order of the Canadian Department of Marine, one of which it is expected to launch in August and deliver in September. It is expected to complete the second vessel before the close of navigation.

In regard to the Eastern Car Company it was reported that the recent order for 550 general service cars had been completed, and that another order for 500 all-steel flat-cars was making good progress. It was stated that all indebtedness to the parent company was liquidated, and that the assets of the Car Company had been largely added to during the current year.

Some improvement was reported in connection with the output and production costs at the collieries.

NEW PLANT FOR TORONTO.

The John Wood Manufacturing Company of Conshohocken, Pennsylvania, have purchased the modern plant of the Holden-Morgan Thread Miller Company on Coxwell Avenue, Toronto, comprising 3¾ acres, with two large mill buildings and several smaller ones, and will engage in the manufacture of welded range boilers, storage tanks, gasoline tanks and similar goods. It is their intention to begin work as speedily as possible, and they expect to be in production early in September. This concern is one of the oldest manufacturing companies of Pennsylvania. Their line of "Electric Weld" products are well known throughout the United States and Canada.

Profit-Sharing Plan.—The Dominion Sheet Metal Corporation, one of Hamilton's largest industries, has inaugurated a profit-sharing scheme for employees. Eight per cent preferred stock will be offered to the employees, the number of shares to be based upon earnings. The offer will be made at par, although the stock has been selling at from 110 to 112 in a limited way. The employees are to pay for the stock at the rate of 2 per cent per month. They will be credited with the 8 per cent dividend at the rate of 2 per cent each quarter, and no charge will be made for interest or unpaid balances. The arrangement means 14 per cent annual credit and no interest charge. All employees are also to have one week vacation, for which they will be paid.

Welland "Telegraph":—The worst industrial blow Welland has ever received was in the decision of the directors of the Canadian Steel Foundries last week to dismantle the Welland plan and ship the machinery to Montreal. The work began on Monday and by the end of the week much of the equipment was on the way to Montreal, and the balance of it was loaded or being loaded on cars. A year ago this firm was employing about eight hundred hands.

It is stated that the land and buildings will be offered for sale at once. Prospects of sale, however, are very remote. The plant was built for a specific purpose, and unless for an industry of closely allied nature it would not be likely to prove suitable. The industry began a dozen years ago as the Ontario Iron & Steel Company, financed principally by Albany interests. It was agreed at the beginning that $200,000 would be spent in plant and that 100 hands would be employed. It had some years of hard sledding and frequent changes of management before being taken over by the Canada Car and Foundry Company, the present owners. The company spent thousands of dollars in new equipment. They specialized on railway work, and their product annually was in excess of five million dollars. The company operate many plants—at Fort William, Amherst, N.S.; Longue Pointe, and Point St. Charles. It is believed that the closing of the Welland plant marks the first step in the consolidation of all the plants in Quebec.

The Dominion Steel Corporation's ore-freighting steamer "Maskinonge" was recently damaged by striking an iceberg between Sydney and Wabana. She will be out of the service until repairs are effected.

Nova Scotian newspapers report that the United Mine Workers at the Cape Breton collieries are to meet on July 2nd and that proposals will be put forward for a general strike in protest against the action of the Dominion Government in arresting the Winnipeg strike leaders, and for a five-day week at the collieries. So far as the five day week is concerned, there is likely to be little difficulty in connection with this proposal,

as the collieries are having a considerable number of idle days enforced by the lack of outlet for the coal produced occasioned by the holding of the Dominion Company's steamers under requisition by the British Admiralty. The mine workers may be very glad to get five days work per week during the coming months. Proposals for a five day week come chiefly from the contract workers, who can by extra effort increase their wages, but men paid by the day, particularly the lower-paid men with large families, will experience hardship should such a regulation be enforced. Behind the proposal is the old heresy that limitation of production will improve trade conditions. And all the time the American producers are busy cultivating the Montreal market.

Notice has been given in the Supreme Court of Nova Scotia of intention to foreclose the mortgage on the railway property of the Inverness Coal & Railway Companq which runs between Inverness and Port Hawkesbury for a distance of 65 miles in Inverness Co., Cape Breton Island. The Inverness Coal & Railway Company —which is a MacKenzie-Mann property—has for some time been in the hands of a Receiver, and the Inverness Colliery is the sole remaining operating coal property of any importance in Inverness County. On the suggestion of the Chief Justice, action on the motion was deferred until the matter could be brought to the attention of the Commissioner of Works and Mines of Nova Scotia and of the Minister of Railways.

The Inverness Colliery, which depends upon the Railway for the carriage of coal to a shipping port, is entirely a submarine mine, the face workings being about 7,000 feet from shore. The Inverness coal is a favorite house coal, and has been largely used for many years for this purpose and for steam-raising in Nova Scotia and Prince Edward Island.

Milton L. Hersey, Henry H. Vaughan, Walter A. Jannsen and others have taken out letters of incorporation as the General Combustion Co. of Canada, with headquarters at Montreal, with nominal capital of $100,000, with the intention of manufacturing electric furnaces and electric heating devices, etc.

Hamilton Lindsay, Alexander Winton, George Hayes Brown and others of Cleveland, Ohio, have incorporated the Niagara Wire Weaving Company with place of business at Niagara Falls, and a capital of $220,000, for the purpose of manufacturing wire cloth.

Letters of incorporation have been issued to Charles Lawrence Dunbar, Leo William Goetz and others to acquire the business of oxyactylene welders and machinists formerly carried on in Guelph by R. B. Lang and John Skidmore, and to do business under the style of the Lang Manufacturing Company, with capital stock of $40,000.

The Anglo-American Wire Rope Company, Montreal, has been incorporated with a capital stock of $200,000 by Alexander Chase-Casgrain, Errol McDougall, Leslie G. Bell and others to manufacture wire and wire products. Supplementary letters-patent have been issued authorizing the change of title to the "Anglo-Canadian Wire Rope Company, Ltd."

INDUSTRIAL CONGRESS, CALGARY, AUGUST 11-16th, 1919.

Eastern Manufacturers Urged to Attend.

Western Canada is to have a great industrial congress dates August 11-16, to which manufacturers and industrial leaders of the continent as well as those of the United Kingdom are being invited.

The purpose of the congress is educational to a large extent along industrial lines, though one of the avowed intentions is to promote and increase the friendly relationships between the United States and Canada and to create a greater unity as between Eastern and Western Canada.

Subjects up for discussion are: Western Markets, Western Industry, Pacific Trade and Transportation Routes, Oriental Commerce, the future alignment as between East and West in so far as manufacturing is concerned, and the great question of building up the Pacific regions and the adjacent inland territory.

The congress is assuming international importance and thousands of American manufacturers as well as those of the Eastern part of Canada as well as England will be on hand. The discussions are to be made by men foremost in industry and science as applied to industry on this continent. Among those who will speak are Sir Robert Borden, Prime Minister of Canada, Henry Ford, Harold McCormick, head o fthe International Harvester Co., E. W. Beatty, president of the Canadian Pacific Railway, Robert Dollar, head of the Dollar Steamship lines and many others.

All interested in industrial development in the West or in Western markets are invited to attend. The movement is accompanied by a propaganda to the effect that eastern factories which sell to Western markets in bulk should build branches in the West.

The congress dates are August 13 and 14 at Calgary, Alberta, though a trip through the territory and including other western Canadian cities will commerce at Medicine Hat, Alberta, August 11, and conclude at Edmonton, the capital city, where the Premier and Government Members will entertain the guests. A side trip will be made to Canadian Rocky Mountain resorts.

Congress headquarters have been opened at the Palliser Hotel, Calgary, Canada, where a staff is employed to give further information.

DEATH OF JOHN McDOUGALD, COMMISSIONER OF CUSTOMS.

In the death of John McDougald, Canada loses a public servant of an unusual type. His services to the iron and steel industry of Canada were great, and he had a first-hand knowledge of the industry gained from his close connection with Pictou County, Nova Scotia, where he was born and first entered public life, and where he witnessed the genesis from very small beginnings of the Nova Scotia Steel Company.

John McDougald was not only Commissioner of Customs for 23 years past, but was a potent force in the framing of tariffs. His advice and exact knowledge of the technicalities of tariffs and their effect on the business of the country will be missed at this time.

BY-PRODUCT OVENS IN BRITISH COLUMBIA.

,The Consolidated Mining & Smelting Company has erected by-product coke-ovens at Anyox, B.C. The plant provides for the recovery of benzol and toluol. Arrangements have been made for treatment of the tar in Vancouver.

British Iron Ore Resources

By PROF. H. LOUIS.

One of the most marked effects of the war has been the stimulus that it has given to the development of the mineral resources of the British Empire, and particularly of those of Great Britain. For many reasons the more active exploitation of our home iron ores has been one of the most prominent features of this movement. Up to the invention of the Bessemer process the iron industry of this country depended practically exclusively upon domestic ores, the bulk of the ores smelted being the claybands and blackbands of the Coal Measures; in addition to these the red haematites of the Mountain Limestone of the West Coast and some of the Jurassic ironstones were also worked, but up to about 1870 the iron-ore deposits of the Palaeozoic rocks formed the mainstay of our British iron industry. When the Bessemer process introduced mild steel as an important factor in the industry, the relatively small production of West Coast haematite no longer sufficed for our needs, and as many of our centres of iron smelting are situated within easy access of the coast, Bessemer ores were naturally looked for abroad, and an energetic importation of foreign ores ensued. Bilbao ore was first imported about 1870, and by 1878, after the Carlist War, this importation had reached 850,000 tons; in 1913 the importation from Spain, to which Almeria and other parts of Spain contributed as well as Bilbao, was 4,500,000 tons, while our total imports from abroad, by far the greater part of which was Bessemer ore, amounted to about 7,500,000 tons. The domestic ore production was 16,000,000 tons, of which about 12,000,000 tons came from the Jurassic ironstones. The growth in the output of these last-named ores was due in large measure to the increasing adoption of the basic process of steel-making. When the war rendered the importation of foreign ores difficult and expensive, our iron and steel industry had to rely more and more upon basic steel produced from the latter class of ore. This development has been favored by the grudging recognition that for most purposes basic steel properly made is as good as acid, and, furthermore, by the abandonment by the Board of Agriculture of the so-called citric acid test for basic slag in favor of its valuation by the total phosphoric acid present; this means that, whereas, under the former 'made in Germany' test thousands of tons of British basic slag had to be dumped out at sea as unsalable, such slag can now be utilized and its phosphoric acid centents rendered available for the British agriculturist. At the same time, the British steel trade now has a market opened up for what was before a waste product.

One of the signs of the increasing interest taken in domestic ores is the attention that is being devoted to the study of our iron-ore resources. Apart from some earlier descriptions of British iron ores, which have today at most only an historical interest, the first attempt at a real estimate of our iron-ore resources was that published by the present writer in the important treatise issued by the Eleventh International Geological Congress at Stockholm in 1910. This showed for the first time the magnitude of Britain's iron ore reserves, and attracted much attention on the Continent; it would be interesting to speculate how far it may have contributed toward Germany's intention to bring about the war, one of the main motives of which was Germany's desire to obtain possession of the French iron-ore fields and thus to outstrip all competition by commanding far the largest iron-ore supplies of Europe. The principal value of the above-named estimate today lies in the fact that it has formed the basis of newer and more accurate estimates. Since the beginning of the war three important contributions to our knowledge of our own iron-ore resources have appeared, each under the auspices of a government department—it need scarcely be added, having regard to our characteristic British methods, a different department in each case, working independently of the others. Nothing could be more eloquent of the need for a central administration, co-ordinating such efforts and avoiding useless duplication of work. The first was the now well-known report on the resources and production of iron ores, etc., by Mr. G. C. Lloyd, issued by the Department of Scientific and Industrial Research, which appeared in May, 1917, a second revised and enlarged edition being issued toward the end of the same year.

In the spring of this year an important paper was read by Dr. F. H. Hatch before the Iron and Steel Institute by permission of the Controller of Iron and Steel Production, Ministry of Munitions, the data for this having been collected by Dr. Hatch working for that Ministry. It deals with the Jurassic ironstones of the United Kingdom, and, as has already been shown, these constitute by far the most important of the British iron resources from the economic point of view. The deposits dealt with comprise the Northamptonshire, Cleveland, Leicestershire, Oxfordshire, Lincolnshire, and Raasay ironstones, and full descriptions are given of their geology, mode of occurrence, and chemical composition, the numerous tables of analyses being particularly valuable. Finally, Dr. A. Strahan, Director of the Geological Survey, has recently issued his annual report, in which he presents very interesting estimates of the quantity of iron ore that may fairly be assumed to exist in the various deposits. This is a summary of an extensive series of investigations upon British iron-ore deposits which the Geological Survey has been recently conducting, the detailed reports upon which are being awaited with much interest. It constitutes a portion of the very valuable Special Reports on the Mineral Resources of Great Britain the first volume of which was issued in November, 1915; in the introduction to this volume Dr. Strahan has set out clearly the object of these resports and their economic significance.

The present report summarizes as follows the iron-ore resources of Great Britain under two heads: (a) reserves more or less developed, and (b) probable additional reserves. The figures are:

	(a) Tons.	(b) Tons.
Haematites, etc.	42,500,000	75,000,000
Mesozoic ores	1,775,052,160	2,104,886,000
Clay-ironstones and blackbands	1,065,637,000	6,248,475,600

Dr. Strahan says that the estimates are 'framed in a cautious spirit,' and this statement may readily be accepted. Indeed, as regards the last class, the figures are palpably under-estimated; thus the probable additional reserves are given as about 6,250,000,000 tons,

of which four fifths are credited to South Wales and Monmouthshire, the coalfield which Dr. Strahan probably knows best. There is no reason to suppose that the other British coal fields fall so far short of South Wales in iron contents as collectively to contribute only one-fifth of the whole, and in some cases the figures are clearly wrong. For instance, for the whole of the great northern coalfield he gives only 1,500,000 tons, apparently taking the Redesdale area alone, while Durham is not even mentioned. Yet such ironstones were worked extensivly at Shotley Bridge and other places in the Derwent Valley, as well as at Waldridge Fell, Urpeth, Birtley, How Law, and other points in the county of Durham, while in Northumberland they were worked at Wylam and Lemington in the extreme south of the county, and at places so far apart as Haltwhistle, Hareshaw, Redesdale, and Brinkburn. There is no evidence whatever that the ironstone was worked out at any of these places, but quite the contrary, and there is at least a probability that it underlies the entire coalfield, though whether it will ever prove to be workable is another question; Dr. Strahan, however, points out that he is 'concerned only with the quantities that exist,' quite apart from their workability. It must, indeed, be admitted that this part of the quesion is one of scientific rather than of economic interest, and in any case the full reports are not yet available, though it is to be hoped that they soon will be. All contributions to our knowledge of our own mineral resources are of the greatest value to the nation at the present time.

PIG IRON AND SPIEGELEISEN FROM SCRAP STEEL.

Frank H. Crockard (Mr. Crockard was formerly President of the Nova Scotia Steel & Coal Co., and is now in charge of the Woodward Iron Co., of Alabama), of Birmingham, Ala., has been granted a patent (U. S. 1,274,245) covered a method of making pig iron from scrap steel.

In certain territories in the United States it is impossible to make what is known as Bessemer pig iron on account of the high content of metalloids, such as phosphorus, carried in the ores from which the pig iron is made. The patentee's invention contemplates the use of all steel scrap of a suitable character to produce a Bessemer grade of pig iron, without the addition of any ore to the charge. The blast furnace is charged entirely with steel scrap, with the requisite percentage of a flux, and with coke for the purpose of melting the scrap and furnishing the carbon for recarburizing the molten product in the furnace. The smelting is then carried on as usual. By this process a grade of pig iron is produced which cannot be obtained directly from the use of ores carrying phosphorus in excess of the Bessemer limits.

he iron so produced can be used for many purposes for which high phosphorus irons are not suitable, such as the manufacture of ingot molds for steel works and as recarburizing materials used in the manufacture of high carbon steels.

This same process, it is suggested, can also be used to advantage in producing spiegeleisen. By introducing into the charge of the furnace a small proportion of manganese ore with the scrap, flux and coke, a regular grade of spiegeleisen can be produced, which it is impossible now to do from ores carrying phosphorus in excess of the Bessemer limits.—From "Iron Age."

ELECTRICAL ENGINEERS TO FORM CANADIAN INSTITUTE.

There is more than usual interest attaching, at the moment, to the question of whether the electrical engineers in Canada shall form themselves into a Canadian Institute of Electrical Engineers or whether they shall merge their identity in the organization which, until recently, has been known as the Canadian Society of Civil Engineers and is now called the Engineering Institute of Canada. The new name would indicate the intention that all branches of engineering should be included in one large and more comprehensive organization, but beyond the change in name there is little evidence that the personnel of the Engineering Institute of Canada is different from that of the Canadian Society of Civil Engineers. This view is borne out by the fact that neither the Society of Mechanical Engineers, the Society for Chemical Industry, the Canadian Mining Institute, Canadian branches of the American Institute of Electrical Engineers nor the Municipal Association of Electrical Engineers have looked upon the proposition of becoming part of the Engineering Institute of Canada with favor.

So far as electrical engineers are concerned, it is apparently the practically unanimous opinion that their first interest, and duty, lies in doing all in their power to develop the industry of which they form a part. It is true that there are certain things in common between electrical engineers and others engineers, but the relationship is not nearly so close as that between electrical engineers and electrical manufacturers, jobbers, central station men, contractors and dealers. The development of electrical engineering as a profession is tied up hand and foot with the development of these other sections. No one element in the industry can prosper, or even exist, without the others. All these elements are members of the same family—a young one, truly, but growing very rapidly—to which every member must contribute his quota.

What we electrical men need—and we need it very badly—is some scheme of organization which will bring our various elements into close working relationship. We are as yet, so to speak, merely held together by sentimental ties of common interest. Cold business demands, however, that the electrical industry, as a whole, should be organized under one general head—it may be an individual or a group of individuals—which shall look upon the whole industry as a unit and administer the various departments impartially, having nothing in view but the highest development of the whole—just as the manager of any private industrial concern co-relates his various departments to the end that the business over which he has been placed may be increasingly prosperous. The easiest way to accomplish this end would seem to be through a common council, containing representatives from all the sections of the industry. This, however, presupposes some corporate body to elect these representatives. There is such a body of electrical manufacturers, of jobbers, of central stations and of contract-dealers. There is none of electrical engineers. Isn't the first logical step the formation of such a body, whether you call it the Canadian Institute or Electrical Engineers or any other name?—Electrical News, Toronto.

The Cost of Coal Production as Influenced by the Balancing of the Working Organization

By the Editor.

The initial cost of fuel very gravely and intimately concerns manufacturers and fabricators of iron and steel, and at the present time the high costs of mining coal are probably the chief deterrent to lower prices for iron and steel products.

Prominent among the reasons for the increased expenditure required to produce coal is the unbalanced condition of the working forces at the collieries, primarily due to the requirements of military service.

At the collieries in Nova Scotia voluntary enlistment acted in a very discriminating manner, because by a natural selection there was attracted to the colors the very pick of the productive forces at the collieries. The specifications of military fitness, which as is well known were more exacting in the early months of the war than was the case later, encouraged the selection of young men, physically vigorous; and, by a similarly discriminating process, voluntary enlistment chose the men of mental and spiritual energy. The effect of all this upon the colliery organizations was extremely partial, because, in the first instance, the nature of underground employment tends to create two fairly sharply divided classes of workers, in the first of which classes, usually known as the "producers" will be found the young, vigorous and more ambitious workers employed chiefly at the "face" where the actual digging of coal takes place. The second class, namely, the so-called "non-producers," include the shiftmen, repairers, haulage attendants and the surface workers, and these men are, broadly speaking, made up of boys too young for work at the coal-face, and older men past their prime, or unfitted by capacity or inclination for actual production of coal. Among the first-named class are also to be found a large percentage of young married men, because the miner reaches his maximum earning capacity in early manhood, and he usually marries early.

The effect of voluntary enlistment was therefore to greatly reduce the numbers of the producing class, and to reduce very slightly, or not at all, the non-producing classes. The financial result was inevitable, seeing that the tonnage of coal produced sharply declined without any diminution of the overhead charges and the cost of taking the coal away from the face. This unbalancing of the working forces at the collieries has been, and still is the main factor in increasing the production costs of coal.

Apparently this phenomenon is not peculiar to Nova Scotia, and, with the close of the war, some figures are available from British sources showing that a similar cause has operated to raise the production costs in Great Britain. The following figures, condensed from some informative tables compiled by Mr. Finlay A. Gibson (Secretary of the Monmouthshire & South Wales Coal Owners' Association) compare the annual coal production of the United Kingdom for 1913 and the war years, with the number of workmen on the surface and underground, and show the percentage of increase or decrease from the standard of 1913:

A study of the table will show that while the production of coal in 1918 fell to 21 per cent below that of 1913, the number of workmen employed on the surface was only lessened by two per cent.

If it were possible to still further separate the figures of the underground workers into face-workers and the remaining classes, it would undoubtedly be apparent that the entire reduction, or nearly so, would be found in the number of the workmen employed at the coal-face.

Read in conjunction with the foregoing tables, Sir Auckland Geddes' recent announcement in the House of Commons that the production of 1919, owing to the reduction of the working hours to seven hours per day, would not exceed 214,000,000 tons, and that the number of workmen engaged in the industry is now equal to the average of 1913, namely 1,111,000 men, it is quite clear that the cost of coal in Britain must be rapidly increasing.

There is no data available on which to institute comparisons with the United States in this connection, but, as that country was able to learn from our experiences, and was able to organize for war under a selective draft system that avoided the dislocation of pivotal industries, it was also able to avoid the unbalancing of the colliery organizations to the same extent as occurred throughout the British Empire as a whole. There was some little inconvenience in 1914 when British citizens and citizens of other belligerent countries went home in large numbers from the United States coal districts, but between that date and the entry of the United States into the war the colliery forces had been recruited to normal strength.

During the war period, the United States took advantage of its unparalleled resources of coal, and increased coal production in a really marvellous fashion, and that it was able to do so, was largely due to the fact that the selective draft recognized the necessity to retain coal producers at their work.

The larger steel companies of Canada are all miners of coal for their metallurgical processes, and there is probably no department of their operations which is

			Workmen Employed.					
Year.	Tons.	% *	Underground.	% *	Surface.	% *	Total.	% *
1913..........	287,441,869	..	909,834	..	218,056	..	1,127,890	.
1914..........	265,643,030	— 7	915,381	— 1	218,365	..	1,133,746	..
1915..........	253,179,446	—12	754,673	—17	198,969	— 9	953,642	—15
1916..........	265,348,531	—11	792,911	—13	205,152	6	998,063	—11
1917..........	248,473,119	—13	811,510	—11	209,830	— 4	1,021,340	— [illegible]
1918..........	227,714,579	—21	794,843	—13	214,024	— 2	1,008,867	—1[illegible]

* Denotes percentage of increase or decrease compared with 1913.

more important in its bearing on their ability to compete in the steel markets than the question of economical organization at the collieries for the production of coal.

It is perhaps some little consolation to know that similar factors of increase in cost are operating in other countries, or otherwise Canada would be placed at a serious disadvantage. The inclusion in the draft of the League of Nations of the clauses relating to labour and the hours of work may yet serve to safeguard those allied countries where the rate of production is being decreased and the cost increased by the adoption of greatly shortened hours of work.

AN APPRECIATION OF DR. STANSFIELD.

From the July "Bulletin" of the Canadian Mining Institute.

Dr. Stansfield is by birth a Yorkshireman, and obtained his early education at Ackworth School near Pontefract, and at the Technical College, Bradford, where he formed a taste for things electrical which has remained with him ever since. His university course was taken at the Royal College of Science, and Royal School of Mines in London, whence he graduated in the

ALFRED STANSFIELD, D.Sc.
Professor of Metallurgy at McGill University.

Department of Metallurgy, which was then in charge of the late Sir William Roberts-Austen. After graduation in 1891, he spent seven years in the laboratories of the Royal Mint, conducting for Sir William Roberts-Austen, researches, the results of which were published by the Alloy Research Committee of the Institution of Mechanical Engineers. These researches were pioneer work in regard in the nature of alloys, and were carried out with the aid of the recording pyrometer devised by Sir William Roberts-Austen. Apart from the regular work of the Laboratory. Dr. Stansfield published papers on "The Pyrometric Examination of the Alloys of Copper and Tin," "Some Improvements in the Roberts-Austen Recording Pyrometer," and "The Solution Theory of Carburized Iron." In 1898 he obtained the degree of D.Sc of London University, and took charge of the Metallurgical and Assaying Laboratories of the Royal School of Mines. In 1901 he was awarded the Carnegie Research Scholarship and subsequently carried out a research on "The Burning and Overheating of Steel," which was published by the Iron and Steel Institute. The same year he was appointed Professor of Metallurgy at McGill University, which position he hold at the present time.

After coming to Canada, Dr. Stansfield gave up his researches into the theory of alloys and steel, and applied himself to devising processes for the improvement of Canadian metallurgy. His work was directed at first to the electric furnace production of steel, in which research he was associated with Mr. J. W. Evans, of Belleville. He also worked for a long time on the electric smelting of zinc ores. This work was commenced in collaboration with Mr. L. B. Renolds. It was continued for some years for the Department of Mines, Ottawa, and has subsequently been carried further as a technical research for the Weedon Mining Company. The electric smelting of the zinc ores, although most interesting and attractiv, is a research of extreme difficulty and even yet has not attained to full commercial success.

In 1907 Dr. Stansfield brought out the first edition of his book "The Electric Furnace," which was published by *The Canadian Engineer*. The second edition was published in 1914 by the McGraw-Hill Book Company. In 1914, shortly before the war, Dr. Stansfield visited Germany and Sweden, and wrote a Report for the Mines Branch on "The Electrical Smelting of Iron Ores in Sweden." During the war he was associated with Colonel Carnegie and Dr. Wilson on the Copper-Zinc Commission, which investigated the supply of these metals for the Shell Committee, and assisted the subsequent developments which led to the production of zinc and the refining of copper at Trail. Dr. Stansfild was also able to assist Canadian metallurgy by devising a process for the production of magnesium, which is now in operation at Shawinigan Falls.

He investigated experimentally the Colvocoresses process for the production of a copper nickel-steel from the Sudbury ores and in 1918 he prepared an elaborate Report for the British Columbia Government on the "Commercial Feasibility of Smelting Electrically the Magnetite ores of that Province."

Dr. Stansfield became a member of the Institute in 1901, and was elected a Councillor in 1918. He also acted last year as Secretary of the Iron and Steel Section. For several years past he has served as a member of the Publication Committee, and in this capacity has rendered invaluable assistance to the Secretary.

The Position of the Scottish Iron and Steel Trade in Relation to Basic Iron-Ore Supplies

By H. ARNOLD WILSON.

(Reproduced in part from the Journal of the West of Scotland Iron and Steel Institute.)

I should like, at the outset, to say that in offering a paper on the subject of the supply of basic iron ores to the Scottish blast furnaces I do not pretend to be able to speak as a metallurgist or a mining engineer; it is rather the commercial side of the question which I wish to endeavour to put before you, as this is the side with which I am most familiar, and I venture to hope that the subject may not be without interest.

I find that in 1910 a valuable paper on "The British Steelmakers' Ore Supplies," dealing with both bessemer and basic ore, was contributed by Mr. W. H. Herdsman, one of our vice-presidents, and it is largely in response to his invitation that I have ventured to come before you this evening.

Such full information is available regarding bessemer hematite ores, their qualities and sources of supply, that it seemed unnecessary that these should be considered. On the other hand, the importance of the manufacture of basic steel is being more and more realised, and it is no exaggeration to say that a regular supply of cheap basic pig iron is a vital necessity of the Scottish iron and steel trade. We naturally desire to see this pig iron produced in Scotland, so that the availability of supplies of phosphoric ores is today a question of absorbing interest.

The subject may be divided geographically as follows:

First—Domestic ores.
Second—French ores,
Third—Scandinavian ores,
Fourth—Newfoundland ores,

and this is the division I proposed to adopt.

As, however, only certain of these ores are likely to be available for economic use in Scottish furnaces, our attention need not be taken up too much with those which, in the meantime, do not appear to be suitable for use here.

Some remarks will also be made on the question of handling the ore on its arrival at our ports.

Domestic Ores.

The clayband and blackband ores in Scotland are so well known that I do not propose to refer to them specially. The ony new ore which has been discovered within recent years is that in the Island of Raasay, of which the following is an analysis:

Ferrous oxide	30.3%
Ferric oxide	2.3
Oxide of manganese	0.4
Alumina	5.6
Lime	17.6
Magnesia	2.0
Carbon dioxide	28.3
Silica	6.5
Sulphur	0.2
Phosphoric acid	2.3
Water, etc.	4.5
Iron in raw stone	25.2
Iron in calcined stone	35.7
Specific gravity	2.83

The shipment of this ore is made in small cargoes, and it is being smelted in considerable quantities. The Home Office returns show that the quantity of iron ore raised in Scotland in 1915 was 375,241 tons.

The basic ore in Cleveland, Lincolnshire, and Northamptonshire are so situated that the expense of bringing them by rail to Scotland is too high to allow of their being smelted here to advantage, and even if water carriage is considered the cost of bringing the pig iron from these districts is such that no Scottish ironmaster would be prepared to import ore to smelt in competition with it.

It is interesting, however, to note that the following are the figures for the production in 1915:

	Tons.
Cleveland	4,746,293
Lincolnshire	3,149,079
Northamptonshire	2,517,150
Staffordshire	702,231
Leicestershire	685,137
Oxfordshire / Rutland	140,520
	11,941,410

French Ores.

Since the war began a great deal of interest has been aroused in French ores, especially those found in the mines situated within easy distance of the coast. Many of these mines were developed by the Germans, and at one particularly, that at Dielette, in the Province of La Manche, very near to Cherbourg, Messrs. Thyssen had constructed a most elaborate shipping system which was just about ready for operations when war broke out. It is to be hoped that this plant may soon be available to load ore for this country.

The mines from which ore could easily be shipped to this country may be divided into two groups, according to their situation; and for the figures I am about to give I am indebted to Major Raikes, of the Olga Iron Ore Company.

The Normandy Group.—The Normandy group is situated in the Departments of Calvados, Orne, and La Manche, the shipping port of which is Caen—distance, 600 nautical miles from Glasgow—where the large new blast furnace and steel works of Messrs. Thyssen are situated. These ores are generally speaking carbonates, weathered to hematite at the surface, with iron running from 46.00 per cent to 50.00 per cent in the calcined ore, silicon 10.00 per cent to 14.00 per cent, and phosphorus 0.6 per cent to 0.7 per cent. Only in one case, that of St. Remy, is the iron 52.00 per cent to 53.00 per cent in the ore as mined. The distance from the port of shipment of all these mines varies from 5 to 45 miles. The quantity available is very large indeed, and the cost of mining should be small, as the ore can be worked by adit levels or vertical shafts.

To this group may also be added the mines of La Ferriere aux Etangs, situated 45 miles from Caen, which contain a similar ore, the production in 1913 being 150,000 tons.

The cost of putting these ores f.o.b. runs from 2s 6d to 3s per ton.

The only mine which requires special attention in this group is that at Dielette, already referred to, which is an oolitic magnetite ore containing 57.00 per cent iron, 0.07 per cent manganese, 0.24 per cent phosphorus, and 11.00 per cent to 12.00 per cent silica. It lies on the sea-coast, and the ore has simply to be brought down by ropeways to the sea.

The total outputs for these mines in 1911 were as follows:

	Tons.
Calvados	367,575
Orne	352,474
La Manche	10,920

The Maine et Loire Group.—The other group is to be found in the Department of Maine et Loire, the shipping ports for these being Nantes and St. Nazaire, about 650 miles distant by sea from Glasgow. They are not calcined, the ore being an oxydule (ferric oxide), and the percentage of iron runs from 48.00 per cent to 55.00 per cent, silica from 10.00 per cent to 17.00 per cent. The phosphorus varies considerably, and may be taken as from 0.6 per cent to 1.00 per cent. The mines are worked by vertical shafts. They are not quite so favourably situated for shipment, as the railway carriage is longer, being from 90 to 100 miles, so that the rates of carriage are somewhat higher than on the Normandy group. The ore from them is smelted to some extent at Trignac, and is also exported. The output is small at present, the total for the whole group in 1912 being 122,000 tons; but large figures are aimed at in the future, when development is further advanced.

The following is actual analysis of cargoes delivered in Middlesborough in 1918 of ore shipped from Caen under the name of Caen A and Caen B, for which I am indebted to Mr. Herdsman. Most of these are from the Calvados deposits:

	Caen A.	Caen B.	Caen Calcined.
Iron	52.69	46.00	48.00
Manganese	Trace	.10	.50
Phosphorus	.75	.55	.65
Lime	2.85	2.7	4.25
Magnesia	1.0	.6	1.0
Alumina	2.0	5.4	5.25
Silica	7.6	12.9	15.5
Sulphur	.08	.09	.55
Oxygen	22.25	19.5	21.6
Loss	8.80	7.2	2.2
Combined water plus carbonic acid	2.00	4.70	.....
Lump	68	43	50
Rubble	20	34	31
Small	12	23	19

Cargo by cargo only varies 1½ per cent iron and 1 per cent silica.

Smelting qualities good.

Minette.—As regards the enormous deposits of so-called minette ore lying in the Department of Meurthe and Moselle these are eminently suitable for the manufacture of basic iron, as they are high in phosphorus; but their situation makes it doubtful whether it would be possible to bring them to this country, so that only a general description may be given.

The ore is hydrated hematite and oolitic, the iron seldom exceeding 42.00 per cent in the dry ore, and is generally between 33.00 per cent and 40.00 per cent. The phosphorus is most regular between 1.7 per cent and 1.9 per cent, with silica between 4.00 per cent and 7.00 per cent. The moisture runs between 8.00 per cent and 11.00 per cent.

It is happily now unnecessary to separate the ores in what used to be called Germain Lorraine from Belgian-French Lorraine, as we believe that in the future the whole of this district, having now been freed from the Germans, will remain in French hands.

The iron ore mining districts of Lorraine are generally recognized to be the largest deposits at present known to the world.

The ore is classified according to the predominance of lime or silica, it being termed "calcareous" or "silicious" minette. Some of the ore contains a high percentage of alumina, which makes it useless for the blast furnace. The hardness of the mineral varies considerably, but is always decidedly lower than that of limestone, so that mining is an easy matter. Many of the minette ores crumble away very easily, which is, of course, an objection in the blast furnace; others break off in large pieces when being mined, and stand the transport well without crumbling very much. It will be known generally that many of the minette ores are very brittle and crack in the furnace.

The composition of the workable ore reserves fluctuate within the following limits:

	Calcareous Minette.	Silicious Minette.
Fe	26 —40%	30 —40%
CaO	8 —20	4 —10
SiO_2	4 — 8	8 —15
Al_2O_3	2 — 6	1.2— 8
P_2O_5	1.5— 2	1.5— 2

xThe subjoined table shows the composition of the ore from the different seams:—

The quantities are estimated as follows, in millions of tons:—

	Calcareous.	Silicious.	Total.
French Lorraine	2.000	1.100	3.100
German Lorraine	1.428	413	1.841
Luxemburg	125	125	250
	3.553	1.638	5.191

There are in existence only a few mining districts where, with a limited use of machinery appliances in the underground mines an average yearly output of over 1,500 tons per head is reached. In former years this was the case with a number of mines, and even now there are some minette mines which reach this production with purely manual labour. Most of the mines, however, cannot now reach this figure even with their

x

	Fe.	CaO.	MgO.	P.	SiO_2.	Al_2O_3.	Co H_2O.
Red Seam	40.4	8.2	0.5	0.7	9.6	5.5	14.—
Yellow Seam	38.—	9.8	1.5	0.3	7.—	4.2	—
Grey Seam	31.8	19.—	0.5	0.7	7.9	2.3	22.—
Brown Seam	24.—	8.6	2.—	0.6	16.6	6.5	—
Black Seam	39.7	5.9	0.5	0.7	15.1	5.2	14.—

mechanical appliances. During the ten years previous to 1911 the output per head in German Lorraine came to about 1,000 to 1,100 tons. The figures of the French production cannot be compared owing to the number of mines which were at that time only being opened up.

According to the figures published in 1890 by the Bergmeister of Metz, the cost of mining in German Lorraine came to about 1s 2d to 1s 4d per ton. At that time the mining was done almost exclusively by adit levels, and the few shaft mines in existence only reached moderate depths. In those days, as was still the case in 1911 when these figures were taken, mining wages formed the greatest part of the cost, and came to about 65 per cent ot 70 per cent of the value. Working costs must have increased considerably since then, owing to the higher wages paid to-day.

With the exception of the costs for pumping, hardly any difference exists between the working costs of the adit level and shaft mines. They fluctuated for German Lorraine between 1s 6d and 2s 6d per ton, which is made up as follows:—

11d	to	1s 3d	—Wages for working in the mine.
1d	"	2d	—Hauling out of the ore.
½d	"	1d	—Coal.
1d	"	3d	—Wood for timbering the mine.
½d	"	1d	—Separating and loading.
2d	"	4d	—Materials.
½d	"	1d	—Labourers' insurance.
1d	"	2d	—General expenses.
½d	"	1d	—Taxes.

The costs for pumping, which are not included in the above statement, are only of importance in those mines which are worked by shafts, and in some cases came to as much as 6d per ton.

Adding to these depreciation on property and decrease in the value of the mine, the actual costs in German Lorraine came to about 2s to 3s for adit level mines, and 2s 6d to 3s or at the most 3s 6d, for those worked by shafts. In the district of Briey, where only shaft mines are in existence, one could therefore calculate on about from 2s 8d to 3s 4d working costs at an average output of one million tons. There are, however, some mines which, owing to unfavourable conditions, had to calculate with costs up to 3s 9d in spite of an even higher production.

In 1900 230,000 tons were mined in the Briey district in French Lorraine, and only ten years later its output came to 8,440,000 tons.

In 1913 it is stated that 21 million tons out of a total of 36 million tons of ore mined in Germany came from German Lorraine.

The rail rate per ton on ore from Thionville—which is in Lorraine, roughly 20 miles north of Metz—to Dortmund is the same as from Metz to Antwerp.

In 1911 Dr. Kohlmann wrote:—"The works in Rhineland and Westphalia were in the habit of getting large supplies of foreign ores. Besides minette, they used ore from Siegerland, the Lahn district, Sweden, Norway, Algiers and other countries, against all of which the Briey ore would have to compete. If the Briey mines are to be worked to their full capacity, other markets must therefore be found. In this connection the question of the export of Briey ore to Great Britain has been discussed more or less seriously for some time. For a time these plans could not be realised owing to the refusal of the railway companies to cut the rates. The possibility, however, of large quantities of Briey ore being shipped to Great Britain in the near future is by no means impossible."

It looks as if the return of Alsace-Lorraine to France will bring this question immediately to the fore.

In the Briey district in 1911 there were eighteen deep level mines producing eight million tons of ore, and this might easily be increased to 20 million tons in the near future. It is calculated that only 2 million tons of this could be absorbed by Belgium, so that, in order to keep their production at the fullest capacity, other markets must be found for the further ten million tons annually. It does not seem probable that this ore will be sent to Germany, so that, unless a large development takes place in the blast-furnace business in France, a market will be sought in Britain.

Good Briey ore, which was sold about 1907-1908, when the industry was at its best, up to 6s 9d, could be had about 1911-1912 at 3s 3d to 3s 9d per ton. This price still left a satisfactory profit, but if the prices were to go back much further one would get alarmingly near to the working costs.

Scandinavian Ores.

The ores in Scandinavia which are suitable for the manufacture of basic iron are as follows:—

Lapland.—Large deposits are found in Lapland, and, as far as explored at present, they are estimated to contain 1,158,000,000 tons of good iron ore, the following being the names of the principal mines:

Gellivare,
Kirunavaara,
Luossavaara,
Luossavaara,
Svappaara,

the more recently discovered ones being—

Leveaniemi,
Mertainen,
Ekstromberg,
Tuolluvaara.

All the ores are remarkable for their unusually high percentage of iron, seldom less than 60.00 per cent, and occasionally rising to 68.00 and 69.00 per cent. The phosphorus is, as a rule, high, running from 0.6 to 3.5 per cent. Some of the ore however can be obtained with a guaranteed maximum percentage of 0.05 per cent, and in some cases it contains not more than 0.015 per cent phosphorus. The average composition of the principal ores is shown in table on next page.

They are therefore divided, for the purpose of sale, into classes, the classification depending on the percentage of iron and the percentage of phosphorus. The "A" grades could be used for hematite iron production, but all the other ores are too phosphoric.

Tuolluvaara ore averages about 67.00 to 68.00 per cent iron aid 0.25 per cent phosphorus. The sulphur in all these ores is under 0.05 per cent.

The ores are carried direct by rail to Lulea, on the Gulf of Bothnia, and to Narvik, on the Atlantic coast of Norway. Lulea is 1,800 miles from Glasgow, and Narvik, an ice-free port, is 1,275 miles from Glasgow by sea.

The Grangesberg group contains phosphoric ores, which are largely exported to Germany, although some have come to the United Kingdom. The annual exports have lately been about 900,000 tons. This ore is rich in apatite, the iron contents being 57.00 to 62.00 per cent., and phosphorus 0.14 to 1.2 per cent. This ore is shipped at the Port of Oxelosund, which is about 1,300 miles by sea from Glasgow, and is closed by ice during the winter.

All the above ores are of a very hard and refractory character, as will be seen by the fact that the oxide of iron is all in the form of magnetite, and so far they have

not been viewed with favour in Scotland, probably owing to the conditions of smelting obtaining here.

The other ores in Sweden are very low in phosphorous, and are, therefore, not referred to.

The Norwegian deposits are not important, either the quality not being satisfactory or the shipping facilities bad.

The Dunderland deposit, which is estimated at 80 000,000 tons, is very costly to work, and produces an ore very low in phosphorus, used in making haematite iron.

(Table referred to on page 163.)

	Kirunavaara.	Luossavaara.	Gellivare.
Ferrous Oxide	——	——	0.06 — 0.71
Manganous Oxide	0.71 — 9.53	1.64 — 26.33	1.58 — 51.—
Magnetic Oxide of Iron	76.01 —96.1	71.05 — 90.2	72.02 — 95.—
Manganese Oxide	0.13 — 0.93	0.17 — 0.23	0.08 — 0.15
Magnesia	0.62 — 1.15	0.25 — 0.83	0.66 — 1.50
Lime	0.60 14.04	0.50 — 3.8	0.60 — 5.16
Alumina	0.18 — 1.26	1.09 — 1.5	0.44 — 1.71
Titanic Acid	0.05 — 0.50	0.26 1.36	1.55 — 4.80
Silica	0.91 — 1.80	1.34 — 5.74	0.07 — 0.82
Phosphoric Acid	0.02 —10.97	0.007— 1.73	0.04 — 3.18
Sulphur	0.02 — 0.05	0.005— 0.025	0.03 — 0.18
Copper	— 0.002	0.006	——
Iron	51.37 —70.12	64. — 69.2	60.51 — 69.16
Phosphorus	0.007 4.79	0.003— 0.18	0.017— 1.45

Newfoundland Ores.

Amongst the largest known deposits of iron ore is that found on Bell Island, in Conception Bay, on the eastern coast of Newfoundland, which is 1,900 miles by sea from Glasgow. These deposits are operated by two companies—the Nova Scotia Steel & Coal Co., Ltd., which was the pioneer company in this field, and the Dominion Iron & Steel Co., Ltd. The latter, however, utilises the ore only for the operation of its own blast furnace, so that it does not come under consideration this evening.

The Nova Scotia Co., however, in addition to supplying its own iron and steel works at Sydney, mines and exports large quantities annually.

Wabana ore, as this ore is called, is in quality a basic red hematite ore, and the following is the latest complete analysis:

SiO_2	11.30		
Alumina	2.60		
P_2O_5	2.02	P	.88
Fe_2O_3	75.90	Fe	53.13
S	.00		
CaO	2.40		
MgO	3.00		
MnO	1.50		
Moisture	2.00		
	100.72		

The extent of this deposit is unknown.

On 8th October, 1913, in the Government suit against the United States Steel Corporation, Mr. Edwin E. Ellis, of Birmingham, Ala., formerly with the United States Geological Survey, testified regarding these iron mines. He said that claims had been taken as far as 12 miles out from the shore, and that it is planned to operate working of that length. He estimated the reserve at 3,250 million tons, allowing for workings five miles long.

Mr. Edwin C. Eckel, also formerl with the U.S. Geological Survey, testified that in Newfoundland there were 3,500 million tons of economically available ore within a radius of five miles of Bell Island. Besides this there are billions of tons which were not economically available at that time. In one deposit alone the ore was 30 feet thick, and contained 90 million tons to the square mile.

Mr. Eckel estimated that ore could be brought from Newfoundland mines to Philadelphia at a cost of about 4 cents per unit. Foreign ore sells at Philadelphia at 7 to 7½ cents per unit. Lake Superior ore cannot be laid down at Baltimore and Philadelphia for less than 9 cents per unit, or from 2 to 2½ cents per unit more than the foreign product.

These under-sea deposits have been opened up by slopes driven from the land workings, and are worked in a manner similar to the bord-and-pillar method followed in coal mining.

A very extensive and complete equipment has been installed to operate these areas. The most powerful set of winding engines in British North America haul the specially designed steel-bottom dump cars in which the ore is transported to the surface. A new type of deckhead, in which the ore is handled automatically at a great saving over old methods, has been erected, containing a very complete set of crushers, picking-belts, and conveyors. Haulage on the underground levels is by side dump cars operated by small electric locomotives, the ore being dumped into large storage bins over the hoisting slopes. From the mines to the shipping pier the ore is transported by a double-track tramway using over seven miles of cable.

A special feature of the plant is the loading equipment, which consists of two piers. These piers are situated on the south side of the island, which offers deep water and good shelter. The piers are located at a distance of about 500 feet from the storage bin, and at a lower level.

The ore is conveyed from the workings to the storage bin in cable cars, and is discharged from the bin on to an endless bucket conveyor. Each conveyor is fed by a separate storage pocket constructed in a natural gulch in the precipitous cliff, the bottom of which is 200 feet blow the dumping trestles on to which the tramcars run. As the buckets pass under the bin they are loaded, and pass out to the head of the piers, where they deposit their load into a chute conveying it into the steamer's hold.

By means of the most modern mining, transport, and loading machinery, steamers of 13,000 tons cargo capacity have been fully loaded in 3 hours. These shipping piers can accommodate steamers with a draught of water up to 30 feet.

The usual shipping season at Wabana is from April or May to December. During the early part of the year ice interferes with shipping.

The mechanical condition of Wabana ore is roughly as follows:—

Lumps	52%
Rubbles	34
Smalls	14

This is an average of a year's deliveries to the Tees.

Although the ore beds have been worked for over twenty years now, the ore is practically the same as at the beginning; if anything it has improved in the last few years since work was commenced in the centre of the three parallel beds of ore.

With a deposit of ore the limits of which are as little known as when work was commenced on it over 20 years ago, a geographical position commanding the markets of both the European and American continents, and the cheapest possible water transportation, the Wabana ore properties are in a unique position. There are larger deposits worked, and there are some which have a higher percentage of iron in the ore, but it is doubtful, however, if there exists hin the world any deposit that so combines the advantages of good ore, easy mining, excellent location, and cheap transportation.

The quantity shipped from Wabana to Canada, Europe and America before the war amounted to a total of about 600,000 tons annually, but the mines have been so much developed during the period of the war that an annual output of 1,000,000 tons could now be reached.

Transport and Handling.

The essence of the problem of securing cheap supplies of ore is that of economic transport and handling. The larger the steamer which can be handled, the more economical is the freight. It is practically impossible for the buyer to control the conditions under which the ore is loaded, but arrangements must be made for the rapid discharge of the largest possible steamers in the shortest possible time, and after the ore is discharged it must be carried from the port to the furnace as economically as possible.

Facilities in the Clyde ports, including Ardrossan, are in this respect woefully behind those of our greatest competitors, America and Germany.

We cannot expect ore to be brought in steamers such as are run on the great lakes of America, which are practically one long hatch, with some engines in the stern. We have to deal with ocean-going boats. For the same reason we cannot use grabs capable of lifting 15 tons at a mouthful, as are used on the lakes in America, but we could do great work with smaller grabs, as I shall now show you.

I have the records of various ocean-going steamers which have been discharged at North Sydney, Philadelphia, Rotterdam, and Emden.

North Sydney.

The discharge pier at North Sydney, Cape Breton, Nova Scotia, used in connection with the blast furnaces of the Nova Scotia Steel and Coal Co., Ltd., handles boats such as can be brought into the Clyde. Their discharging apparatus consists of two Wellman Seaver steam gantry cranes, which discharge into waggons or on to a stock pile on the opposite side of the quay, and the following is a record of a series of cargoes, showing the actual times occupied in the discharging of s.s. "Wascana" and "Wagama" in 1917 and 1918. These two boats are single-deckers, and temporary wood hoppers were placed in the wings of the ships, so that the ore was practically self-trimming.

s.s. "Wascana" in 1917 *at North Sydney.*

Docked.	Completed Discharging.	Time. Hours.	Quantity. Tons.	Tons. per Hour.
Aug. 29th—10.00 p.m.	31st—5.30 p.m.	43½	7,200	166
Sept. 10th— 5.00 p.m.	12th—6.00 a.m.	37	7,300	197
Sept. 16th— 7.30 a.m.	17th—8.00 p.m.	36½	7,600	208
Sept. 21st— 2.30 p.m.	23rd—4.00 a.m.	37½	7,600	203
		Average Tons per Hour		192

s.s. "Wagama" in 1918 *at North Sydney.*

Sept. 10th— 8.30 a.m.	12th— 8.30 a.m.	48	7,400	154
Sept. 19th— 7.30 p.m.	21st—11.00 a.m.	39½	7,350	186
Sept. 26th— 9.30 a.m.	28th— 3.00 a.m.	41½	7,200	171
Oct. 3rd— 6.30 a.m.	5th— 4.00 p.m.	58½	7,200	123
Oct. 11th—11.30 a.m.	13th—noon	48½	7,500	155
		Average Tons per Hour		155

s.s. "Themis" at Philadelphia.

Arrived.	Sailed.	In Port. Days.	Hours.	Tons.	Tons. per Hour.
1911.					
Aug. 1st— 7.00 p.m.	4th— 4.00 p.m.	2	21	12,364	179
Sept. 14th— 6.00 p.m.	17th—10.00 a.m.	2	16	12,450	195
		Average Tons per Hour			187
1912.					
June 7th— 8.00 a.m.	10th— 4.30 p.m.	3	8½	12,413	154
June 26th—10.00 a.m.	29th— 5.00 p.m.	3	7	12,466	158
Sept. 23rd 1.00 p.m.	26th— 6.00 p.m.	3	5	12,467	162
		Average Tons per hour			158
1913.					
July 15th noon	17th— 5.00 p.m.	2	5	12,079	228
Aug. 19th— 3.00 p.m.	22nd— 6.00 a.m.	2	15	12,183	193
		Average Tons per hour			209

I have not got a record of these boats at Philadelphia or Rotterdam, as the larger boats, s.s. "Themis" and s.s. "Tellus," were used for these ports, where they could be accommodated. Unfortunately such large steamers cannot be handled at all in the Clyde, but they are the most economical ore carriers. I can give you the records for the discharge of a series of cargoes delivered at both Philadelphia and Rotterdam by these steamers.

Philadelphia.

In Philadelphia the ore is discharged by grabs worked by four Brown hoists, and is put direct into waggons.

Rotterdam.

In Rotterdam the work was done by grabs, but the ore was discharged direct into lighters, although the grabs could be used for putting the ore into railway waggons if so desired. The lighters which take the ore up to the works in Westphalia run from 1,500 tons to 2,000 tons. The freight on the Rhine was 1s per ton from Rotterdam to the Duisburg-Rheinhausen district, a distance of about 150 miles. The ore was discharged by grabs from the lighters, and was therefore delivered extremely cheaply to the works on the Rhine.

The following are records for the discharge of a series of cargoes by the "Themis" and "Tellus":—

s.s. "Themis" at Rotterdam.

1914. Arrived.	Sailed.	Time. Hours.	Quantity. Tons.	Tons. per Hour.
May 26th— 9.00 a.m.	28th—12.30 p.m.	39½	11,687	296
June 19th— 8.45 a.m.	20th—10.00 p.m.	37¼	11,888	319
July 15th— 6.00 a.m.	14th— 3.00 a.m.	45	12,064	268
		Average Tons per hour		289

s.s. "Tellus" at Rotterdam.

1914.				
May 25th— 6.00 a.m.	27th— 3.30 a.m.	45½	11,807	259
July 14th—10.00 a.m.	16th— 5.00 a.m.	43	11,965	278
		Average Tons per hour		269

Emden.

The following are the records of two cargoes delivered in Emden by s.s. "Gladstone" and s.s. "Othello" in 1913:—

s.s. "Gladstone" at Emden.

		Days.	Hours.		
Nov. 21st— 5.30 p.m.	26th— 4.30 a.m.	4	13	7,396	68

s.s. "Othello" at Emden.

Nov. 11th—noon	15th— 1.45 a.m.	3	13¾	5,685	66

Glasgow.

The usual experience in Glasgow is that although grabs have been tried they have been of a small type, rigged on cranes which were not intended to be used for working grabs. The heaviest grabs are, I understand, the 3-ton size.

Wonderful work has been done in Glasgow with the old tub, loaded by gangs of men with shovels. In pre-war days ore has been discharged at fully 60 tons per crane per hour by this means, but this rate has not been equalled for years.

Under war conditions, the Ministry of Munitions compelled the Clyde Trust to work day and night, and also saw that the railway companies provided waggons. They also compelled the labourers to discharge iron ore on piecework. By these means the actual time taken in turning a boat round was greatly improved. Now that the war is over the night work has been stopped, and it seems as if piecework would also be stopped.

When all is said and done, it must be generally agreed, I think, that shovelling ore is not a white man's job. Indeed it is about the most laborious form of labour which can be conceived, and it seems certain that, with the high cost and scarcity of labour, mechanical means of discharging iron ore from steamers must be adopted if we in Scotland are to keep abreast of the times.

A further most important matter is that of discharging waggons at the works. Here again the same remark applies. Bottom-dumping waggons worked on gantries is the simplest method. At present a vast amount of time and labour is expended in shovelling ore out of waggons, and very often a steamer has to wait for empty waggons coming back from the works owing to the difficulty in getting labour to discharge them.

In order to show the great saving in cost which can be accomplished by turning a steamer round rapidly, I give the following figures:—

Take the case of a 10,000 ton boat at pre-war figures, say 3s per ton deadweight per month. The value of the boat is 1,000s per day, or, say 1/10th of a shilling per ton. The best rate of discharge that we were able to arrange in pre-war days was 800 tons per 24 hours. At this rate, it would take 12½ days to discharge the boat. If, on the other hand, the boat could be discharged at the rate of 2,000 tons per day, which, compared with other ports, would still be a comparatively slow rate, the time occupied would be five days, and the actual saving on time-charter hire would be 9d per ton of ore. It is difficult to say what the present rate for time-charter would be; but supposing it were 24s per month, the saving would be no less than 6s per ton.

It is manifest that if ore is to be attracted to Scotland an enormous improvement must take place in the despatch given to steamers, otherwise the sellers will deliver at Philadelphia or elsewhere, and only come here in the very last resort, while the cost of basic pig iron is enhanced by twice the extra cost of delivering the ore, reckoning on a yield of 50 per cent iron in the ore.

In conclusion, therefore, I cannot emphasise sufficiently the vital importance to the whole iron and steel industry of Scotland of prompt and adequate arrangements being made at the ports for discharge, by the railway companies for forwarding, and by the iron-masters for discharging their supplies rapidly and cheaply.

The By-Product Coke Plant at Clairton, Pennsylvania

FRANK F. MARQUARD,
Superintendent, By-Product Coke Plant, Carnegie Steel Co., Clairton, Pa.

A paper read before the American Iron & Steel Institute May Meeting—(Condensed.)

The Clairton By-Product Coke Plant, without exaggeration, stands to-day as the climax in the development of the by-product coke oven industry of the world. It is the most comprehensive in plan of operation, the largest in size and in detail of construction the most complete.

By-Product vs. Beehive.

The delayed recognition of the merits of the by-product coke oven industry has resulted in enormous waste. In the past twenty-five years, in this country, the beehive ovens have wasted in tar and gas, reduced to coal equivalent, an amount equal to over 300,000,000 tons of coal, and a waste of over four hundred million dollars ($400,000,000) worth of ammonia, and over five hundred million dollars ($500,000,000) worth of benzol products, these conservative amounts being based in each case on sub-normal prices.

The beehive oven is primitive, crude, wasteful, and, in the light of the present-day experience in the operation of by-product ovens, the beehive oven will soon play a very minor part in the coke production of the country.

In the past few years there has been a wonderful awakening. The construction of by-product ovens has been greatly extended. Their merit as an essential industry in time of war, as well as peace, is now recognized by our Government as of national, as well as of economic interest in the development of the iron and steel industry.

In the year 1918 sixty million (60,000,000) tons of coke were produced in this country—thirty millions by the by-product ovens and thirty millions by the beehive ovens; and this year, 1919, will mark the turning point in favor of the production of by-product coke.

In planning the construction and operation of this large plant, three important questions were very carefully considered:

Location so as to effect maximum economy in transportation of coal, gas, and coke.

Type of oven and recovery apparatus most effective for the production of the best metallurgical coke from the coking of 100 per cent high volatile coal.

Market for the coke, tar, gas, ammonia, benzol, coke dust and domestic coke.

As to location, we have been extremely fortunate in having a site located north and adjacent to the Clairton steel plant of the Carnegie Steel Company. This site is 5,200 feet long, and 1,800 feet wide, lying along the western shore of the Monogahela River, 20 miles south of Pittsburgh, and large enough for the construction of 24 batteries of 64 ovens to the battery.

Twelve batteries, 768 ovens, are completed, with a daily coal consumption of 12,500 net tons of coal per 24 hours.

In order to handle these large quantities of coal and coke, we found it necessary to construct a river fleet of 120 barges and 7 tow-boats to transport our coal from the mines to the ovens; 8 miles of main line track and 20 miles of yard track; a 40″ diameter gas line, 9 miles long, to deliver the gas to Duquesne, Homestead, Edgar Thomson and Clairton Steel Works; seventy-five 10,000-gallon tank cars for tar and benzol; 500 steel hopper coke cars; coal storage yard of 250,000 net tons capacity, to take care of a possible interruption in our river traffic in winter months, and to assure uniform oven operation, etc.

The coking of 100% high volatile coal for the production of suitable, metallurgical coke had not yet passed beyond the experimental stages when the Clairton plant was designed and considerable interest was centred upon the performance of the blast furnaces using this by-product coke made from 100 per cent high volatile coal. The results obtained at the Clairton Steel Works blast furnaces soon demonstrated that the coke could be used successfully in place of Beehive coke. Not only did these furnaces increase their production of pig iron, but they did so on a lower coke consumption; and the larger blast furnaces of Duquesne and Edgar Thomson, after some preliminary adjustments, quickly responded by increased production and low coke consumption in a manner most satisfactory.

In the description of this complete by-product plant it is difficult to convey a true conception of its size and operation, and I have therefore supplemented my paper with motion pictures to show upon the screen operations which would take many pages to describe.

To follow the plant construction in its sequence of operation, I have started at the coal hoists.

Daily Production and Yield from 12,500 N. T. Klondike (Fayette Country) Coal per 24 Hours.

Daily Production		Per Cent Yield—Based on Coal Charged
8,000	N.T. of dry screened furnace coke (2½% H_2O)	62%
520	N. T. small size coke (domestic coke)	4.2%
900	N. T. coke dust	7.2%
150,000	gals. coal tar	12 gals. per N. T. coal
162	N. T. sulphate of ammonia	25 lbs. " "
29,000	gals. pure benzol	2.3 gals. " "
7,400	gals. pure toluol	.57 gals. " "
2,800	gals. crude light solvents	.22 gals. " "
1,400	gals. crude heavy solvents	.11 gals. " "
75,000,000	cu. ft. surplus gas (575 B.T.U.)	6000 cu. ft. " "

The Clairton Plant is equipped with two electrically operated coal hoists, each hoist consisting of two 5-ton hoisting buckets having a lifting capacity of 500 tons per hour. The coal is lifted from the barges and dropped into a 150-ton hopper, from which it is spread over a shaking screen to roll-crushers. This screen has slotted openings 2½″ by 11″, and the crusher rolls are set 2″ openings, so that approximately 60% of the coal passes through the shaking screens, the oversizes going through the rolls, leaving the rolls to crush only the large lumps. Thus we are able to secure a maximum density of coal; that is, there is always sufficient fines present in the coal to fill up the voids, however coarse the coal may be crushed, and experiments have shown that by this method of crushing we are able to secure a coal of maximum density. Coal crushed in this manner will average 52½ pounds per cubic foot, while coal pulverized by hammer mills will average 6 to 8 per cent less per cubic foot.

If we had been forced to resort to a mixture of low volatile coal, it would have been necessary to crush all of the coals to a small size in order to effect a thorough mixture. It has been demonstrated that the sizes to which the coal is crushed (a factor determining the density) has a direct influence on the quality of the coke, and this important point in the operation of the Coke Plant should receive very careful consideration. In the use of 100% high volatile coal, that is, volatile 33 to 35 per cent, I am convinced that the denser the coal charge the better the quality of coke.

The coal after it leaves the crusher is mixed with the fines that pass through the shaking screens and is fed on a rubber belt then conveyed up a 15° incline to bunkers. The 12-battery plant is equipped with four bunkers, each bunker having a capacity of 4,000 tons of coal. Each bunker supplies three batteries. The coal is drawn from the bunker into larry cars. These larry cars are equipped with four cone-shaped hoppers, the capacity of these being just sufficint to fill one oven which requires 13.3 net tons of coal per charge. It is important in the charging of the ovens to see that the oven is charged to its fullest capacity, for the reason that not only do we secure thereby the maximum production of coke per oven, but we limit the gas space in a maner which allows the gas to pass out of the oven quickly without lingering in contact with heated walls, such as would be the case where ovens are irregularly filled. The charging and levelling of the coal in the oven requires approximately one and one half to two minutes, during which time the gases are allowed to escape. As soon as the coal is levelled the lids are properly secured and the gas from the ovens is then allowed to pass up through the ascension pipe into the collecting main.

The ovens are Koppers Standard 500 cubic foot ovens, 37′0″ face to face of doors, 17″ wide on the Pusher Side and 19½″ wide on the Coke Side, 9′10″ floor to roof and 9′0° floor to top of coal when charged.

Each battery of 64 ovens is made up of 232 different silica shapes and 98 clay shapes. The total 9″ brick equivalent for each battery is approximately 2,529,000 brick.

The ovens are individual cross-regenerative type, having 16 vertical flues on the pusher side and 14 vertical flues on the coke side, all connecting into a common horizontal flue near top of oven. Each oven has two independent air regenerating chambers filled up with 9″x3″x3″ and 9″x2½″x2½″ clay brick and 9″x2½″x2½″ silica brick, having a total mass of approximately 164 cubic feet in the pusher side chambers and approximately 152 cubic feet in the coke side chambers. The bottom tier of regenerator brick are 9″x3″x3″ clay brick, so laid that the gas space between the bricks varies from ¼ of an inch on outlet side of chamber to ½ inch at far end of chamber to more equally distribute the air through the checker work. All other brick are 9″x2½″x2½″ clay brick, except the top five courses which are 9″x2½″x 2½″ silica brick.

That proportion of the gas which is returned to the ovens as fuel for heating same, is delivered to each battery through a Venturi meter, and then to a 20″ O.D. main on each side of the battery. From the fuel gas main it is introduced alternately to each side of the ovens through gun brick made up of clay shapes having a 4″ diameter hole and suitable outlets on top to receive a nozzle brick for each vertical flue. The openings in the nozzle brick are semi-eliptical and vary from .49 sq. in. to .35 sq. in., increasing towards the centre, furnishing a means of taking care of the pressure drop in gun brick and the changed volume of the heated gas. The nozzle bricks in the end flue, on each side, are of large size to make up for radiation losses caused by the oven doors.

The air for combustion enters the regenerator chambers under suction through air valves in the connection between the bottom regenerator chamber and the side stack flue. This inlet is opened and closed by the automatic reversing mechanism—being open when the reversing damper on the same side is closed. The amount of air entering can be controlled at this point by more or less restricting the opening by the use of strips of steel called finger bars. The air passes up through the regenerators, is heated to 1700 F, (927° C), and enters the vertical flues, where combustion takes place. These air openings into the vertical flues are 6.213 sq. in. in area, except the end of the flue which is 9.281 sq. in., to supply additional air for the greater amount of gas burned in the end flue. Each vertical flue is continued above the horizontal flue to the top of the battery where it is covered by a cast iron cap. This cap furnishes a means of inspecting each flue and also a means of changing nozzle brick or sliding brick settings.

The openings from each vertical flue into the common horizontal flue is regulated by a sliding brick in order to secure uniform pressure condition in each vertical flue. The gas is burned up the vertical flue in such a manner that the tip of the flame extends approximately 24″ from the top horizontal flue.

The products of combustion are conducted from the vertical flues on one side of the oven into the horizontal flues, across and down through the vertical flues on the other side, and through air ports into opposite regenerator chambers, where the gas is robbed of most of its sensible heat. From the regenerator chamber the waste gas is conducted through the air box to the stack flue, thence to the stack. On 19 hour coking time the average vertical flue temperator on low heated coke is 2300° F, (1260°C).

The draft on individual ovens is controlled by a butterfly damper in each air box, connecting the regenerators with waste gas flue leading to the stack. The butterfly dampers are set wide open for the re

generator farthest away from the stack end, and gradually contracted toward the stack so that each regenerator of the entire battery of 64 ovens is under the same draft conditions, individual ovens, however, may be given more or less gas to compensate for variable conditions that may exist.

The stack flues parallel each side of the battery, uniting into a single flue at the reversing end of the battery, thence to the stack. The stacks are built of reinforced concrete, brick lined, are 8′6″ in diameter and 200′0″ high. At a point near the junction of the two main flues, each flue has a reversing and regulating damper. The reversing damper, during operation, is either wide open or closed according to the side the gas is burning on. The regulating dampers have hand control, and when once set are left in position as long as the desired differential exists between the two flues. The main stack flue has a hand regulated damper by which the draft may be regulated, affecting both flues without affecting the distribution of draft between the coke and pusher side flue.

Summary of the Points of Variable Control:

(1) Pressure of gas in fuel gas main on each side of battery.

(2) Size of opening in nozzle brick in each vertical flue.

(3) Setting of sliding brick at top of each vertical flue.

(4) Setting of draft butterfly dampers in air boxes from stack flues.

(5) Setting of regulating dampers in pusher and coke side stack flues.

(6) Setting of regulating damper in main stack flue.

(7) Number of finger bars in air inlet to regenerators.

It can readily be seen that these points of regulation are all more or less inter-dependent and furnish a very flexible means of control.

The gas is reversed every half hour by a clock energizing a motor driven master control. First, the gas is shut off by closing individual valves in the line from the fuel gas main to the gas gun. The valves on either side of the battery are all connected by a rod and cable to separate gas cock machines. Second, the reversing dampers are reversed, the same machine reversing the air opening in the air box. Third, the gas cocks on the opposite sides are opened. The gas is put on by the gas cock machine releasing cable allowing counterweight to open cocks. The gas is taken off by the machine pulling against the counterweight and is positive in action.

The various steps in reversing are so timed that enough time interval is allowed between each operation for the flues to clear themselves of any explosive mixtures. Every operation —reversing, gas pressure, temperature, gas consumption, etc.—is recorded by clock recording instruments.

In as much as the gas is introduced through the gun brick and nozzles, located in such position in the oven that they become heated to a point high enough to break up some of the fuel gas with the deposition of carbon, it is necessary to provide means of decarbonizing them. This is done by opening the cap on each gas gun several minutes after reversal on the opposite side, from which the gas is burned, allowing air to be drawn into gun brick and nozzles, burning the heated carbon.

After the volatile matter is all driven off from the coke, which at present is completed in 19 hours, and which can be accomplished in less time, the doors are removed and the coke is pushed into the quenching car and is brought under a spray of water and quenched for 45 seconds. In order to quench this coke in this time 6,000 gallons of water per quench are required, 1,000 gallons of which evaporate. It is important to quench this coke in a manner which will give a coke containing not more than 3% of water. The coke is then allowed to drain one minute and dropped upon a wharf from which it is fed, by a rotary feed to a rubber belt, passed over a stationary bar grizzly screen, made up of hard iron bars set with space 7/8″ top and 1 1/4″ bottom, 6 sets of bars, each bar 24″ long, and through chutes into cars. The fines passing through the grizzly screen amount at present to approximately 18% of the total coke discharged from the oven. These fines are rescreened through a rotary screen with 3/4″ wire mesh openings, where the larger sizes are separated from the dust. The larger sizes are available for domestic fuel, while 80% of the dust is required to produce all the steam requirements for the entire coke and benzol plants.

The gas coming from the ovens enters a collecting main through ascension pipes and mushroom valves. The collecting main is "U" shaped and so designed as to give the gas a speed of approximately five feet per second, and the suction main is so designed as to give a speed of travel of approximately fifteen feet per second. In order to maintain uniform gas pressure in the collecting main a butterfly regulating valve is inserted in the suction main and is controlled by an electric contrivance known as a Northwestern Governor. This valve is set so as to hold a pressure in the collecting main at 3 1/2 mm of water.

The gas leaves the ovens at an average temperature of 600°C, enters the collecting main at 400° C and leaves the collecting main to the suction main at 200°C.

The heavy tars are quickly condensed and drop out in the collecting mains and in order to prevent this

The Following are Clairton Average Settings and Readings on 19-Hour Coking Time.

Gas pressure on pushing side	40 mm of water
Gas pressure on coke side	50 mm of water
Stack draft on pusher side	21 mm of water
Stack draft on coke side	22 mm of water
Temperature of waste gas at base of stack	275°C
Gas burned per hour pusher side	180,000 cu. ft.
Gas burned per hour coke side	200,000 cu. ft.
Back pressure in collecting mains	2.5 mm of water
Average draft at top of regenerator chamber—pusher side—	.36″ water
Average draft at top of regenerator chamber—coke side—	.40″ water
Opening in air inlet to regenerators—pusher side—	84.7 sq. in.
Opening in air inlet to regenerators—coke side—	59.7 sq. in.

pitchy tar from building up and stopping the mains, a constant stream of what is known as flushing tar is flooded through these mains. This flushing tar is a mixture of 50% tar and 50% ammonia liquor. This carries the heavy tar and such pitch as is formed to the end of the main, where the hard pitch is screened out and removed. The gases in their travel from the ovens to the primary coolers are reduced 200°C to 75°C. During the cooling, 70% of the tar is condensed in the collecting mains before the primary coolers are reached, 20% is condensed in the suction mains and approximately 8% of the lighter tars, and most of the water vapors, are condensed in the primary coolers. The temperature in the gas inlet to the primary coolers is 75°C, while the outlet from the primary coolers is 28°C. The liquor and tar are combined and the mixture flows to a circulating drain tank from which it is pumped to the tar separating tank.

In order to maintain uniform operating conditions it is extremely important that the even temperature control of the gases be constantly maintained. After the gases are passed through the primary coolers, they are under a suction of 30 c.m. of water. The Clairton Plant is equipped with five Connersville Exhausters, each having a capacity of 40,000,000 cu. ft. per 24 hours at 100 R.P.M. Each exhauster is driven by two simple, non-condensing, direct conected, Hamilton Engines, built by the Hooven, Owens and Rentschler Company.

After passing through the exhauster, the gas is raised in temperature by compression, from a suction of 15″ of water to a compression of 50″ of water. The gas is then passed through the tar extractors which eliminate the last traces of tar vapors by mechanical means, i.e., forcing the gas through finely perforated plates and allowing it to impinge upon a flat surface, which breaks up the little tarry mist into globules. The gas, thus free from the tar, is preheated to a temperature of 60°C and then passed through the lead lined saturators containing a solution of 5% Sulphuric Acid. The gas coming in contact with this acid gives up all of its ammonia which forms Ammonium Sulphate ($(NH_4)_2SO_4$). After this acid bath becomes saturated, the crystals of Ammonium Sulphate fall to the bottom and are ejected with an air syphon ejector and thrown upon a draining table. The mother liquor is returned to the saturator and the salt is periodically paddled into the centrifugal dryer.

These dryers are 40″ in diameter and have a copper screen perforated with 5/64″ holes, backed up with #18 gauge, 11 strands to the inch, copper wire mesh, with copper screen perforated with 5/16″ holes on the outside, and during the drying process are speeded up to 650 R.P.M. The salt is built up on the walls of this centrifugal dryer to the extent of 4 or 5″ and is whizzed for a period of 15 minutes, after which it is washed with a small quantity of hot water and whizzed for another few minutes. The dryer is then stopped and the salt is scraped off the copper screen with copper paddles and dropped upon a rubber conveying belt and is discharged into a revolving drum dryer known as air-heated dryer in which the moisture is reduced from 2% to less than ¼ of one per cent.

The normal specifications of Sulphate of Ammonia, call for a Sulphate of Ammonia containing not under 25.00% ammonia (NH_3). This would enable us to have a moisture content not to exceed 2%. However, a considerable demand exists for a very dry sulphate, in which the moisture content is .15%. In order to .15% and the acid content under .15%. In order to secure these results, the air-heated dryer drum has been introduced and this high grade quality procured.

Practically all the Sulphate of Ammonia is used as a fertilizer—in some cases blended with bone dust and in many cases used without mixing with bone dust or phosphates or other fertilizing mediums. From the analyses of the coal it will be noted that it contains approximately 5% of combined water and 3% of free water, making a total of 8% of water. This water is condensed and dissolves out of the gas and the tar a certain amount of Ammonium sulphide and Ammonium Carbonate and practically all of the Chloride of Ammonia. Thus the ammonia which is taken out of the gas by this water amounts to approximately 20% of the total ammonia content of the gas.

This weak liquor, as it is called, contains about 1% of total ammonia (NH_3), is separated from the tar by gravity, in separating tanks, and is put through ammonia stills where it is brought in intimate contact with a solution of lime water and steam. The lime combines with the ammonium chloride forming calcium chloride, and the ammonia is driven off as a gas and is led through cast iron pipes into the gas mains before the saturators, thus, all being converted into sulphate of ammonia. If, however, there is a market for concentrated ammonia liquor, the ammonia gases from the ammonia stills, instead of being conducted to the saturators,, are condensed into liquor and sold as ammonia liquor containing 20% to 25% (NH_3).

The tar, after it has been allowed to settle and the ammonia liquor separated (which takes place by gravity), is then loaded into tank cars of 10,000 gallon capacity. Most of the tar is shipped to the open hearth and heating furnaces, where it is burned in connection with coke oven gas as a fuel for the production of open hearth steel, and the remainder is disposed of to various tar-using industries.

The following is a typical analyses of Clairton Coal Tar:

Moisture	1.25%	
Specific gravity	1.156 (at 15°C)	
Viscosity	140 at 60°C (Saybolt method)	
Free carbon	4.25%	
B.T.U. per pound	16,200	
Sulphur	.55%	
Distillation—		
Light oil (0° to 170°C)	.20%	
Carbolic oil (170-230°C)	9.60%	3% carbolic acid. 6% cresylic acid
Creosote oil (230-270°C)	10.20%	
Anthracene oil (270-350°C)	23.00%	
Pitch (at 350°C)	57.00%	
Coke residue (at 1200°C)	17.20%	

After the gas passes the ammonia saturators, it is passed through final coolers where it is brought in direct contact with a water spray and cooled from 60°C to 25° C, at which temperature it is passed through the oil scrubbers.

These oil scrubbers, arranged three in a series, are 16'0" indiam. and 100'0" high, filled up with wooden grids for 80'0" in such a manner that the oil which is trickling down through the grids from a series of 24 sprays at the top comes into intimate contact with the gas. The wash oil, as it is called, absorbs the benzol vapors from the gas. These oil scrubbers are so designed that the gas will have a speed of not under three feet per second and a time of contact through these series of three scrubbers of not less than 60 seconds. In this manner 90% to 96% of all the benzol vapors are extracted from the gas at a temperature of 25°C and the oil will have a saturation of 2½ to 3% of benzol and its homologues.

The gas, after it has been debenzolized, is metered by a Thomas Meter, i.e., an electric meter which measures the current required to heat up the gas 2°C, after which it is passed to a 100,000 cubic foot regulating holder. Forty-three per cent. (43%) of this gas is required for heating up the ovens, while the remaining 57% which is designated "surplus gas," is sent to the booster station where it is boosted by steam driven turbines to a pressure of 7 pounds and delivered through a 40" gas main for a distance of 6 to 9 miles, supplying gas to the steel mills at Clairton, Duquesne, Homestead and Braddock. The following is a typical analyses of Clairton debenzolized (fuel) gas:—

Carbon Dioxide (CO_2)	1.8%	by volume
Carbon Monoxide (CO)	3.5%	"
Illuminants (C_2H_4)	3.0%	"
Methame (CH_4)	36.6%	"
Hydrogen (H_2)	53.9%	"
Nitrogen (N_2)	3.2%	"
B.T.U.'s. Calculated	582.9%	"
Hydrogen Sulphide as Sulphur, pounds per 1,000 cu. ft.	.75 Lbs.	

The wash oil, thus saturated with benzol and its homologues to the extent of 2½ to 3%, is pumped to the wash oil stills at the benzol plant, where it is heated up to a temperature of 150°C through superheaters, then led into the wash oil stills where it is brought into contact with live steam where the benzol vapors are driven out of the wash oil. These are condensed and separated from the water and form what is known as light oil. The wash oil, thus debenzolized to a point where it contains less than .3% light oil, is cooled off through pipe coolers and returned to the scrubbers to take up another load of benzol.

The light oils coming from the light oil stills, contain approximately 8% of wash oil and naphthalene. This wash oil and naphthalene are removed by distilling the light oils in an intermittent still known as a crude still (capacity 20,000 gallons), thus, approximately 2% of the benzol and its homologues are distilled off, leaving a residue of naphthalene and wash oil. This residue is drawn into a decanter tank and forced by air pressure into cooling pans where the naphthalene is crystallized out and the wash oil is returned to the circulating system.

The light oil analyzes approximately as follows:

Crude Benzol	63%
Crude Toluol	16%
Crude No. 1 Solvent	8%
Crude No. 2 Solvent	5%
Wash Oil and Naphthalene residue	8%

In this crude distillation the total benzol fractions with the exception of the heavy No. 2 Solvent are combined, while the heavy solvent is separated. The combined benzol fractions are then pumped into a lead lined agitator which is capable of holding 10,000 gallons of crude benzol. Then .4 pounds of 66° sulphuric acid per gallon of product is added (acid being added in small quantities) and the content is agitated for a period of three hours, after which the sludge, which consists mainly of thiophenes and unsaturated hydrocarbon compounds, is removed and drawn off into an acid pot. After the benzol is sufficiently washed with acid, which is determined by laboratory tests, it is then washed with water and neutralized with a 10% solution of caustic soda. The water and the caustic soda are drawn off and this washed benzol product is then pumped to the pure stills where the product is either fractionated into pure porducts or refined into mixed products, according to the market requirements. The loss sustained in washing amounts to 9% of the product washed, while the loss sustained in the pure still amounts to 8% of the product in residue and non-condensable gases.

The paper concludes with a complete inventory of the plant equipment, which is too long to reproduce here.

The present installation consists of 12 batteries of 64 ovens, or 768 ovens in all, and it is expected that the complete plant will consist of 24 batteries.

In addition to the by-product buildings and equipment, which is very complete and includes a light-oil recovery plant and apparatus for the refining of benzol and the production of washed toluol, the plant is equipped with a drinking water system, fire protection system, laboratory, office and other small buildings. A completely equipped machine shop is provided, with blacksmith and boiler shops. Conveniences for communication and employees' use include a telephone system, bathrooms and toilets and a sewage disposal plant.

For the housing of the workmen, 500 modern dwelling houses, 4 to 9 rooms each are provided, equipped with furnace, running water, gas, electric light and bath. Five boarding houses with accommodation for 128 men are erected, and there are fifty 3-room houses for colored families, and a community laundry and bath-house for colored families.

Very complete transportation facilities are provided, including storage capacity for 250,000 tons of coal, 500 steel hopper cars for coke shipments, and a fleet of 120 steel barges with a capacity of 1,000 tons each on a nine foot draft.

A NEW USE FOR ANTIMONY.

Antimony, injected intravenously, has been found to be an absolute specific for two of the most intractable parasitic diseases afflicting human being in Egypt. It has been found that antimony used in this way will kill not only the parasite in its habitat in the body, but will also destroy the ova and prevent the patient from being a "carrier" of disease. It is not to be expected that any increased demand for antimony will arise from this discovery, but it is an interesting reminder that the use of metals is very varied.

Book Reviews

Iron and Steel

By Erik Oberg, Editor of "Machinery," and Franklin D. Jones, Associate Editor of "Machinery." Published by the Industrial Press, New York. 328 pages, with illustrations, 6½ x 9¼ ins.

This work summarises in plain language and in a fairly comprehensive way the history and present practice in the manufacture of iron and steel. It is not intended for the use of operating specialists in the actual manufacture of iron and steel, but "as a text-book suitable for students in technical schools and those in the machine-building and mechanical engineering fields, who want a broad general survey of the iron and steel industry, with definite practical information pertaining to the various commercial forms and grades of iron and steel products, and the particular class of service for which the different grades are applicable."

Within these specified limits the work is admirably suited to its purpose, and presumably has been written out of the experience which the editorial staff of "Machinery" have acquired of the necessity for such a work among those whose business it is rather to use iron and steel than to manufacture it.

The volume is modern in its references, and we notice some sane references to the comparative values of iron ores as influenced by location and commercial considerations. There is an interesting description of the various methods of iron ore "beneficiation."

An unusual illustration is that of the "spark ray" and "spark pictures" given by steels of varying constituents, and there is also a well illustrated reference to the microscopic study of steel, and the modern developments of metallurgy.

The chapter on Electric Steel is a fair summary of the present status of the electric furnace, and is illustrated by cuts of the better known types of furnace.

Rolling mill practice is discussed at full length, with much attention to the market side of operating.

The chapter on "Structural Carbon and Alloy Steels" is confined largely to a description of the mechanical qualities of alloy steels, and the references to high-speed steel bear mostly on the duty which may be expected from various well-known alloys.

For those who require a working knowledge of the characteristics of the numerous varieties of iron and steel, and the multiplicity of the names under which these varieties are now offered for sale, the book is well designed.

As the authors remark: "Steel of almost any desired physical characteristics may now be obtained," but the characteristics of modern steels are not sufficiently understood by designers, manufacturers and purchasing agents, to enable full advantage to be taken of their wide range.

QUALITIES OF STEEL FOR GUNS.

Anon. (Machinery, Vol XXV, No. 9, p. 835, May, 1919.)—The metallurgy of gun steel has been greatly altered as a result of the war. As the war drew to a close, steel for large guns was being made in a radically different manner than had ever been thought possible. It was an accepted fact four years ago that only acid open-hearth steel could be safely incorporated in ordnance guns, and the plants especially built in this country adopted this process. The reason for this policy was that it is possible by this process to make unusually pure and reliable metal, and it was thought that this was the only method by which this was possible. The great disadvantage involved is the length of time to produce a heat of such steel. In all such work the complete deoxidation, the formation of the proper slags, and the refinement of the metal consumed from thirteen to fifteen hours in the case of a forty- or fifty-ton heat with the utmost care necessary. As the development of the ordnance program progressed, it was found that the large electric furnace refining hot metal on a basic bottom produced gun steel equal if not superior to that made by the long-drawn-out acid open-hearth process.

While a three per cent. nickel steel was the standard alloy incorporated in many of the guns, it is stated that at a large British plant a plain carbon electric steel was giving entire satisfaction in the last months of th war. It is also reported that in one American plant gun steel that met ordnance specifications satisfactorily was being made in basic open-hearth furnaces — a steel that was tabooed for guns before the war and later. It is probably a fact that had the war continued much longer, the electric furnace would have been the first selected as the agent with which to make ordnance steel. It was even being scheduled for one of the later plants, and this is so, not so much perhaps because of the superiority in quality over acid open-hearth, but because the same amount of suitable metal can be made in about one-third the time.—Abs. Journal Franklin Inst.

EDITORIAL

THE POSSIBILITIES OF CONCEALED IRON-ORE DEPOSITS IN NOVA SCOTIA.

In the current issue (see page 176) will be found a very condensed abstract of a paper prepared by Dr. A. O. Hayes, of the Geological Survey, for the Annual Meeting of the Mining Society of Nova Scotia last April.

Dr. Hayes is the author of the best monograph yet written on the Wabana iron-ore deposit, not the least interesting part of which is the part surmised to have been taken in the deposition of the ore by minute boring algae in an ancient enclosed sea, having a modern parallel in the conditions now existing in the Black Sea.*

It is of considerable general interest therefore that Dr. Hayes, after studying iron-ore occurrences in Cape Breton Island and on the mainland of Nova Scotia should point out the similarity in geological age and in probable method of deposition between the immensely valuable deposit at Wabana, and the scattered and apparently unimportant deposits at Mira, Cape Breton, and near Arisaig, N.S. "Careful stratigraphical comparisons between the Cape Breton and Newfoundland Cambro-Ordovician groups should be made before concluding that iron-ore beds of workable thickness are absent," says Dr. Hayes, with particular reference to Cape Breton.

The process of deduction which leads a modern geologist to his conclusions necessitates a very wide range of knowledge, for the science of geology, as practised today, is not one science but many, any one of which, or a single branch thereof, is more than sufficient for a lifetime's study and research. The reasoning of the geologist is, necessarily perhaps to some extent, expressed in abstruse technical wording, which accounts for the scant attention his work receives from the average business man, but the conclusions of the geologist lead to discoveries of epochal significance, when properly followed up.

Great industrial corporations, controlling as some of them do, vast areas of undeveloped mineral deposits, might very well consider the employment of a geologist to undertake research work. The application of what is called "pure science" to industry is not always apparent. If a trained geologist were put to the study of any given field he might not for many years discover any fact that could be expressed in dollars and cents, but little by little, through the patient adding of fact to fact, there would emerge some astonishing and possibly unsought reward of his labors, for it is a fact not usually appreciated that the great discoveries of the world have been, not the result of chance, but the result of the long process of experiment and observation which is known as research. Let a trained geologist "browse around" a large mineral property untrammelled by directions, let him go his own way and pursue the course that his investigations indicate, and—always provided the proper person is selected—he will in due time produce satisfying results, for it has been truly stated that "Time and money given to provide for scientific research is minute in comparison with the huge amounts derived from the development of the results of research."

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* Wabana Iron Ore of Newfoundland, by A. O. Hayes, Memoir 78 Department of Mines, Ottawa. Geological Series 66.

CUTLERY MANUFACTURE SHOULD ATTRACT CANADIAN ENTERPRISE.

The Montreal "Gaeztte" contains the following note:

"There is at least one branch of the steel trade in "which England still enjoys supremacy, cutlery and "tools. Sheffield is reported to be quite unable to "cope with the demand for these wares, and orders are "being declined because of inability to execute. High "prices have not slackened buying, and the only draw-"back to the trade is lack of workmen, and a decline "in the quality of their work. Germany has been a "vigorous competitor of English tools and cutlery in "neutral markets but that competition is gone for a "time."

Why should not Canada develop a cutlery industry? Recently, Canadian manufacturers of crucible and tool steel have shown ability to compete with the Sheffield product, and we hope as regards German competition that "it is gone for a time."

The control the Germans had upon the Canadian cutlery market was almost exclusive. A "Sheffield blade" could not be purchased at many of the leading hardware stores, and the public were offered the products of Henry Boker & Sons, of Solingen, in most attractive guises. The Boker firm supplied the Canadian hockey skate decorated with such names as "Strathcona," and catered in every way to the desires of our home market. A quiet investigation even today of the razors used at barber shops will show that they are chiefly of German origin, and a tour of the hardware stores will disclose large stocks of Boker's goods. It may be said that before the war the Boker firm entirely controlled the Canadian cutlery market.

Since the war, some very good cutlery has been coming from the United States. Knives, scissors and razors of good appearance and apparently good quality are now an important part of United States imports into Canada. Some Japanese cutlery is coming in, but it is very poor stuff. The Japanese are no novices in the manufacture of cutting instruments, and they can make the very best, but the article now being imported from Japan is a poor imitation of standard British and German grades, and is not a serious competitor as yet.

Sheffield goods will doubtless maintain their excellence, and Sheffield manufacturers will also doubtless maintain their conservatism, one feature of which appears to be a disinclination to enlarge production. If this attitude of the Sheffield cutlery trades continues to restrict importations into Canada, it would appear that a good opportunity to develop a cutlery industry now presents itself in Canada. Presumably our wholesalers are not now so enamoured of Boker wares as they were, and if our friends in the United States can make good cutlery to sell in Canada, why cannot equally good cutlery be manufactured at home? We have all the necessary materials to commence manufacture immediately.

EDITORIAL NOTES.

There seems to be little prospect that building costs will decline in the near future. The value of all buildings is today much greater than it was before the war, and greater than it was say a year ago. Replacement is not so difficult as it was, because of the removal of certain embargoes and restrictions designed to discourage building expenditures during the war period, but it is not any less costly. Insurance schedules should be adjusted to counterbalance the increased value of buildings, or the decreased value of currency, whichever explanation of an indisputable fact is preferred. A scrutiny of insurance schedules and a fair revaluation of properties would in many cases today reveal inadequate insurance.

"The Electrical News" quotes from the Bulletin of the Industrial Commission of Wisconsin as follows:— "The statement has been made numerous times that of "500,000 avoidable accidents annually, 125,000 may be "attributed directly or indirectly to poor lighting. "While definite statistical proof of this statement is "lacking, it is believed to be a conservative estimate."

The Report of the Ontario Workmen's Compensation Board says that secondary causes of accident such as bad lighting cannot be tabulated but that they are often of greater importance from a prevention point of view than the primary cause itself. The Board also states that the employer's responsibility is perhaps greater in cases of non-mechanical accident than he is willing to admit and even greater than he thinks it is. If a workman slips and falls it seems hard to charge the employer as responsible, but the condition of lighting might be directly responsible for the accident.

The arrangement of lighting for the purpose of preventing accidents might well engage the attention of the safety engineer. It is the arrangement of lights rather than their intensity that makes for safety, and the dark places can only be learnt by observation at night. The avoidance of confusing glares and shadows can often be achieved without any extra expense in cost of current or material by a little study and actual experiment at night. If one-quarter of all avoidable accidents are supposedly due to defective illumination, the subject will repay detail consideration.

The July issue of "Machinery" contains an article by Franklin D. Jones, Associate Editor, on "Temperature Indicating and Controlling Systems," which is rather a revelation of the extent to which accurate control of heat processes has been attained by the use of electrical signals actuated by pyrometric devices. The heat-treatment of steel is one of the processes dealt with in the article, and in this respect the editorial calls attention to the perfection to which pyrometric control has been developed, and remarks "these different forms "of mechanically and electrically operated instruments "for regulating temperatures according to what is de- "finitely known about heat-treating processes, are a "practical illustration of the constant trend in indus- "trial organizations away from what someone *thinks* is "right to what has been *proved* to be right." The article, which is one of a series of three, should be read by metallurgists who desire to substitute accurate control for approximations and surmise.

Once the characteristics given by a selected heat treatment are ascertained and recorded, a repetition of the treatment will give the same characteristics again and again, which brings to mind the statement made by Dr. Carpenter of Sheffield that in the near future specifications for steel will ask for a record of the working temperatures maintained in manufacture.

The dependence of Nova Scotia steel business on the cost of coal at the mines has been clearly demonstrated by the decision of the leaders of the United Mine Workers of America in Nova Scotia not to inaugurate a five-days' week without conference with the employers. This decision coincided with the partial cessation of productive operations at the Dominion Iron & Steel Company's steel plant, and with a very plain hint in the newspapers that the two things were not unconnected. The management of the Dominion Steel Corporation quite properly explain that the unascertainable costs of coal-mining due to insatiable requests for wage increases accompanied by ever-decreasing efficiency and quantity of production, render the calculation of quotations too difficult a task for the sales department. While in Nova Scotia, the steel industry is entirely based upon the cost of coal production, it appears to be forgotten by the miners that the large production of coal which had been developed in Nova Sco-

tia before the recent decline in outputs, was only rendered possible by steel manufacture. If the cost of coal rises to a point where steel manufacture is not competitively possible in Nova Scotia, then not only will the action of the miner deprive the steel-worker of employment, but it will also reduce the miner's own employment by the extent to which coal is used by the steel industry. During the year 1918 about sixty per cent of the entire coal production of the Cape Breton companies was used in connection with the steel industry.

A NEW MAGNESIUM ALLOY

It is understood that the Shawinigan Electro-Metals Company has developed an alloy, consisting principally of magnesium, which has been tested in the form of pistons and connecting-rods in an Italian airplane engine. Pistons and connecting-rods of this alloy have also been tested in a number of differing makes of automobiles. The tests all indicate that a very valuable alloy has been discovered, which will have many uses, outside of the numerous applications possible in the aircraft and automobile fields.

While sufficient of the possibilities of the new alloy have been ascertained to make engineers curious, it is understood much careful research work and experimental testing is considered advisable before publishing full information as to the characteristics of the new alloy. For this purpose the Shawinigan Company has established a large research laboratory at Shawinigan Falls in which the many problems will be exhaustively studied and solved, if possible. In due time the Company expects to publish the results of its research work. It is interesting to learn that the alloy is about one-third lighter than alloys of aluminum used for similar purposes.

It machines beautifully and rapidly, and will not "gum" the finest file. It has a very high heat conductivity. It is apparently not brittle. Castings will stand great distortion without cracking. The alloy gives promise of becoming an excellent bearing metal, and it is even believed that this quality will obviate the necessity of employing bushings where connecting rods and pistons of the alloy are used. Where tried in the form of gears, cut from cast blanks, it has worn at least as well as cast iron gears.

Especial interest attaches to the possible applications of the new alloy in air-craft development, as it promises to permit of greater strength, combined with rigidity, with a lesser weight than existing alloys allow, qualities which will prove of advantage not only in the matter of engine design, but in the framework construction of flying machines.

The performances of the Vicker's bombing plane was particularly interesting because of the large amount of steel-alloy contained in its framework, but the flight of the R-34 dirigible, with a large number of passengers was a much more important and significant feat from the viewpoint of practical transportation uses. The great weakness of the dirigible, however, is its inflammability, most unfortunately demonstrated since by the lost of a British dirigible by fire in the North Sea, and the curious fatality which recently took place in Detroit. The combination of a fireproof frame work with a non-inflammable gas such as helium would seem to promise well, and this is one of the problems of passenger air-flight that adds peculiar and timely interest to the development and perfection of a material possessing such physical characteristics as are understood to be shown by the new Shawinigan alloy.

BOOK REVIEW

Mining Engineers' Handbook, Robert Peele. $4\frac{3}{4}$ x 7 x $2\frac{1}{2}$ inches. John Wiley & Sons, Inc., New York, Chapman & Hall, Limited, London, 1918. Price $5.00.

We bring this handbook to the attention of our readers, believing that it is not as yet sufficiently well known in Canada. Under the editorship of Robert Peele, Professor of Mining Engineering in the School of Mines of Columbia University, a staff of specialists has prepared a veritable encyclopedia of that extremely varied and composite of pursuits, namely, mining engineering as practised to-day.

Not since the time of Georgius Agricola has any single person essayed to write a volume descriptive of the whole art of mining engineering, but Professor Peele, by combining the labours and experience of men who are acknowledged leaders and specialists in their chosen branch of mining engineering, has well nigh accomplished such volume.

The volume contains 44 sections, and the best idea that can be given of the scope of the work is to quote a partial list of the sections and their writers, as follows:

Mineralogy, by Professor Alfred J. Moses, Columbia.

Geology and Mineral Deposits, by Professor J. F. Kemp, Columbia.

Earth Excavation, by H. P. Gillette.

Tunnelling, by David W. Brunton & John A. Davis.

Mine Geologic Maps and Models, by Reno H. Sales, Geologist to the Anaconda Copper Mining Company.

Mine organisation and Accounts, by J. R. Finlay, and Cost of Mining by same author.

Mine Air, Hygiene, Explosions and Accidents, by George S. Rice, United States Bureau of Mines.

Mining Laws, by Horace V. Winchell.

Ore Dressing, by the late R. H. Richards.

Each of the sections is fully detailed in itself, for example the Section on Mineralogy contains 116 pages and includes a bibliography of the more important books and papers relating to the particular subject covered.

A set of mathematical tables, and a full index complete the volume.

The book will not only be useful to the mining engineer, but also to the lawyer and other men requiring reliable information regarding mining in all its branches. The arrangement of the book into sections, and the full index make reference easy. "Peele" will doubtless take its place as a standard work of reference along with other well-known engineering handbooks, and we do not see how any student of mining can afford to be without it. The volume contains 2,375 pages, but is surprisingly handy, considering the wealth of its contents. The bibliographies add greatly to the reference value.

Nova Scotia Oolitic Iron Deposits of Sedimentary Origin

By Albert O. Hayes, Can. Geol. Survey.

There are several occurrences of bedded iron deposits in Nova Scotia, which, while they have so far failed to compete with the Wabana iron ore in the open market, indicate the presence of ore formed under similar conditions and point to the possibility of richer ores being found when the country is more thoroughly prospected.

Bedded deposits of iron bearing minerals in Nova Scotia were laid down as marine sediments in three successive periods of geological time in the Palaeozoic era, and contain fossils of the early Ordovician, middle Silurian and early Devonian epocha. Similar deposits of early Ordovician age occur in Newfoundland and form one of the largest iron ore reserves in the world; and the important Clinton ores of Silurian age in the eastern United States of the same type are also represented in Nova Scotia. A study of the Nictaux Torbrook hematites and magnetites gives a clue to the origin of these Devonian deposits, and it may be useful to present descriptions of these Nova Scotia bedded iron ores.

Deposits of the Ordovician Period

Deposits of the Ordovician period occur in Cape Breton county south of the Mira river from Grand Mira to Marion Bridge; in Antigonish county at Doctor's brook and Browns Mountain; and in Pictou county at Piedmont.

From both field and microscopic examination the Mira deposits appear to be of similar origin to the Wabana iron ores, like which they are composed of the silicate of iron and alumina, hematite, siderite, quartz grains and shell fragments, all of which were originally laid down as shallow sea bottom deposits. The magnetite appears to be an alteration product due to the intrusion of igneous rocks.

As yet only a small section of the Cambro-Ordovician sediments has been carefully studied.

In the similar Wabana deposits, ferruginous horizons with thin beds of hematite recur through about 2,000 feet of strata in which there are only three workable beds.

Careful stratigraphical comparisons between the Cape Breton and Newfoundland Cambro-Ordovician groups should be made before concluding that iron-ore beds of workable thickness are absent.

With reference to the iron-ore occurrences of Arisaig, from the evidence obtained, the ore is most probably sedimentary, is of lower Ordovician age, and may be directly correlated with the bedded hematites of Great Belle Island, Conception Bay, Newfoundland. (Dr. M. Y. William's Report is quoted in confirmation.)

Note: Abstract of paper read at the Annual Meeting of the Mining Society of Nova Scotia, 23rd April, 1919, published in the Bulletin of the Canadian Mining Institute for August. By permission of the Director of the Geological Survey.

Deposits of the Silurian Period

These occur in Antigonish county, exposed on Arisaig and Ross Brooks, and in Pictou County about three miles north of Sunnybrae on Blanchard Brook.

These ore occurrences are undoubtedly of sedimentary origin, and appear to be of the same age and horizon, correlating with some of the Clinton ores of the Appalachian region in the United States. Except for the character of the fossils, the ores closely resemble Wabana ores in structure and composition.

Devonian Deposits

Bedded iron ores of Devonian age occur in Annapolis County at Clementsport, and in the Nictaux-Torbrook District. In the last named district 348,639 tons of ore were produced between 1891 and 1913. The mines are now idle and filled with water, so that no underground study of the deposits could be made.

Sedimentary origin of these deposits is shown by petrographical examination, but rocks are much metamorphosed and distorted. Correspondences with Wabana deposits are not enlarged upon. The magnetite present appears to be an alteration product to the intrusion of igneous rocks.

Conclusions

Oolitic iron ore of sedimentary origin was deposited in Nova Scotia at definite geological horizons in three successive periods of time, i. e., early Ordovician, Mid-Silurian and early Devonian.

The ore beds conform to the underlying and overlying strata and contain similar fossil forms to those in the accompanying sediments. The original shell material of fossils even when composed of thin walls of lime carbonate are equally as well preserved in the ore as in the other rocks.

The iron bearing minerals are a silicate of iron and alumina, hematite, siderite and magnetite.

The silicate is found in all the ores and is an original constituent of the marine sediments. Hematite is in part an oxidation product from the silicate and together with siderite was deposited while the materials composing the ore still formed a soft sea-bottom deposit. The magnetite has developed as an alteration product from the hematite and silicate due to the metamorphic action of igneous intrusives, after the consolidation and induration of the strata.

Except for the presence of magnetite the ores resemble closely the Wabana iron ore of Newfoundland and the Clinton ores of the Appalachian region in the eastern United States and owe their origin to the precipitation of iron bearing minerals in shallow marine water.

Advices from Tokio, by way of London, state that the production of steel on a large scale has been begun at the plant of the Oriental Steel Company, a new Japanese corporation capitalized at $25,000,000. The works which are located at Tobata on the northern coast of Kyushu, are in one of the industrial centers of Japan and are patterned after the largest mills of the United States and Europe.

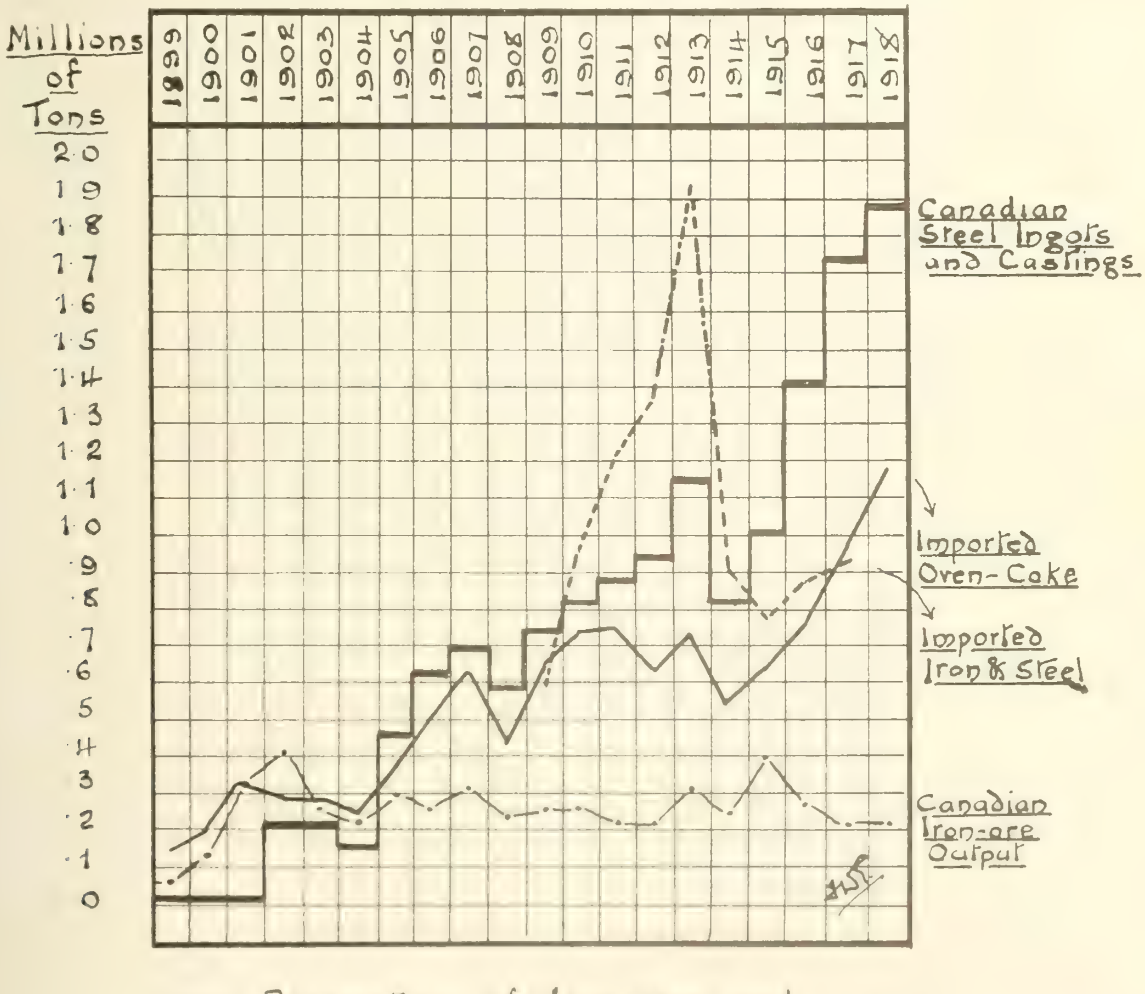
The Production of Coal and Iron Ore in Canada Considered in Relation to the Iron and Steel Industries

By the Editor

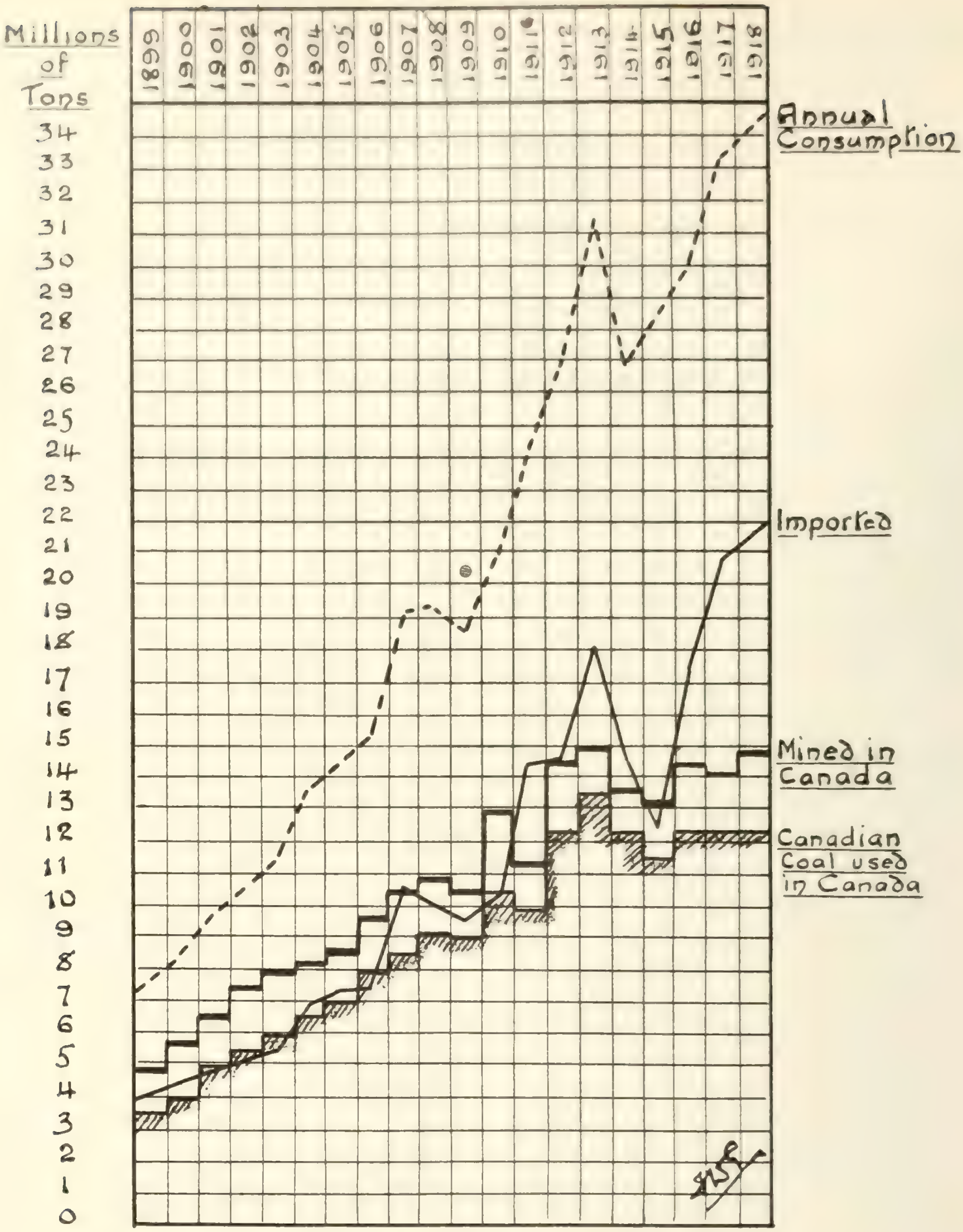
The two graphs accompanying are compiled from the Department of Mines statistics. The graph illustrative of Canadian coal consumption shows that up to about 1912 the Dominion was able to furnish from its own coal-seams a little better than half the tonnage of coal consumed for all purposes in Canada. Actually, however, this was not the case, as a certain amount of coal was exported, chiefly from the Cape Breton mines to Boston, Mass. During the period 1886 to 1899 the coal imported into Canada averaged a little over 54 per cent of the total coal consumption of the country. During the period 1899 to 1918, included in the graphs, the same percentage was maintained, but during the war period the percentage of coal imports has greatly increased. At the present time the imports have risen to 63 per cent of Canadian consumption of coal

The coal consumed in Canada during 1918 is estimated at 34,840,000 tons, the highest figure recorded in Canadian statistics, and most closely approached by 1913 when 31,582,545 tons of coal were consumed. The consumption per capita shows a steadily rising figure, and this is encouraging as showing Canada's progress in the industrial arts and in the conveniences of civilized life, but the discouraging feature diclosed by a study of the statistics is that the Dominion is rapidly increasing its importations of coal, at higher prices than have ever prevailed in the past, and at the same time the home production of coal, shows a stationary, and even a declining tendency. Any form of production in Canada that is stationary is unsatisfactory, and is equivalent to a declining production when viewed in relation to the general growth of population.

There is this difference between the jump in coal consumption that marked 1913 and the peak figure of 1918, namely that in 1913 Canadian coal-mines were increasing their outputs coincidentally with the



— Production of Iron-Ore and Steel Manufacture in Canada. —



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increase in coal imports, but in 1918 the imports of coal are climbing without precedent, while domestic coal outputs are declining with no immediate prospect of manifesting an opposite tendency.

Turning to consideration of the graph showing tendencies in the iron and steel industry, it will be noticed that the tonnage of steel ingots and steel castings produced in Canada has climbed rapidly during the war period. This, of course, is a war condition, and does not represent the industrial growth of the Dominion with accuracy. Nevertheless, the peak reached by imports of iron and steel in 1913 is still higher than the record achievement of Canadian iron and steel plants in 1918, showing that a home market exists and that the producing capacity of the domestic iron and steel industry is required to fill Canadian requirements to a very important extent.

The curve of imports of furnace coke should be considered in relation to the imports of United States coal, and discloses that Canadian steel plants are largely dependent both for coal and coke upon an outside source.

The tonnage of iron-ore into Canada is not shown,

partly because no reliable figures are available, but also because it is unnecessary after inspection of the curve of Canadian iron-ore production. The production of domestic iron-ores is now practically confined to the Province of Ontario. Nova Scotia and New Brunswick, which in former years were important contributors to home production of iron-ores, now produce little or none. It should, of course, be noted that the ore used in the Nova Scotian steel plants, at Sydney and Sydney Mines is Wabana ore, controlled entirely by Canadian interests, but, at the same time, it would be incorrect to class this important part of the tonnage of iron-ore smelted in Canada as of Canadian origin. That is a possibility of the future, politically speaking.

With the exception of the years 1899 and 1900 it will be noted that Canadian production of iron-ore was smaller in 1918 than in any year of the period under review.

A summary of the tendencies disclosed by the graphic representation of statistics of the allied industries of coal and steel in the Dominion includes therefore the following points:

a. Decrease in home production of the essential raw materials of coal and iron-ore, accompanied by a rapid increase in importations of these materials, including a notable increase in the importation of coke.

b. A rising tendency in the importation of iron and steel products into Canada, accompanied by a maximum production of steel in the Dominion, with the probability that a falling-off in steel production may be looked for during 1919. It is not, however, certain that a corresponding decline is likely in imports of iron and steel.

The conclusions to which these consideration would appear to lead is that Canadian steel producers should strenuously cultivate the home market, which appears to have a purchasing capacity worth cultivating.

It appears equally desirable and feasible that Canadian coal producers should strive to lessen the recently developed inequality in the ratio of imported coal to coal mined in Canada. Admitted that a certain tonnage of anthracite coal is probably required for domestic use because of its greater cleanliness, there is yet a large market for bituminous coal in Canada that is being filled to-day from United States sources.

Apart from the fact that raw materials obtained from outside sources provide employment in that outside source and not in the country where they are used—at least not in the same proportion—there is the further consideration that we are to-day paying for imports with a depreciated currency.

In a lecture recently delivered to the staff of Barclay's Bank, in London, Professor Nicholson says with reference to conditions in Great Britain:

> "We are suffering in the first place from "over-importation. During the war a great "part of this over-importation was of the "greatest national benefit. The imports from "America were necessary for the conduct of "the war. But an increasing part of the aggre- "gate money value of these imports was due "to the inflation of the currency and the as- "sociated rise in prices. This part was not a "blessing—quite the contrary."

While a wholesale application of Professor Nicholson's statement is not justified in regard to all the considerations set out in the foregoing remarks, yet in relation to the coal consumption of Canada, the statement is one of fitting exactitude. In brief, we are importing altogether too much coal and we are purchasing it at an increasing disadvantage.

DEATH OF DAVID A. STARR

The "Electrical News" records the death of David A. Starr, General Manager of the Clyde Valley Electrical Power Company, Glasgow, at the age of sixty-one years, who was well known in electrical engineering circles in Great Britain as well as in Canada and the United States, and was born and apprenticed in Halifax, Nova Scotia.

Mr. Starr joined the engineering staff of the Canadian Pacific Railway and subsequently he turned his attention to electricity, and joined the staff of the Thomson-Houston company at their Lynn works in the States, returning later to Montreal as sales manager to the Royal Electric Company. His subsequent Canadian experience covered electric tramways and light railways.

In 1901, the British Westinghouse Electric & Manufacturing Company, Limited, secured his services for their Trafford Park works, Manchester, and in 1903 he was appointed general manager of the Clyde Valley Electrical Power Company. The erection of the company's power stations, and the laying down of their large plant and comprehensive system of mains, were carried out under his supervision, and the present development of the power supply business in the west of Scotland, together with the position of his company as one of the largest in the kingdom, must be attributed to a large extent to his unflagging zeal and energy, and to his sound views on the future of the industry. Mr. Starr was a past-president of the Scottish Section of the Institution of Electrical Engineers, and was closely associated with the work of the Association of Electric Power Companies.

Mr. Starr, who was a son of the late Mr. John Starr, Halifax, Nova Scotia, is survived by a widow, three daughters, and one son. Mrs. Starr was Miss Ella Brown, daughter of Mr. Alexander Brown, Prince Edward Island, and the two elder daughters are Mrs. J. C. Manson and Mrs. H. G. Good. The only son, Alexander, is, since demobilization from the army, associated with his uncle in the business of John Starr, Son & Company, Halifax, N. S.

Personals

Mr. I. C. Mackie has been appointed metallurgist of the Dominion Iron and Steel Company, at Sydney. For ten years past, or thereabouts, Mr. Mackie has been Chief Chemist of the Steel Company, and during that period has had charge of many important investigations, embracing in scope the varied and differing operations conducted by the Dominion Steel Corporation. A reference to Mr. Mackie's work in connection with the properties of rail steel is contained in Mr. G. A. Reinhardt's paper reproduced in this issue of "Iron & Steel of Canada."

Mr. Robert McLellan, the foreman melter at the Open Hearth Plant of the Nova Scotia Steel & Coal Co., at Sydney Mines died very suddenly in the town of Pictou. Mr. McLellan had been in the service of the Scotia Company for over forty years, and was a capable and valued official. He had been foreman melter at Sydney Mines since 1900.

Electrically Heated Soaking Pits, Re-Heating and Annealing Furnaces, and Automatic Furnaces, for Heat Treatment, as Applied to the Steel Industry

THADDEUS F. BAILY
President, The Electric Furnace Co., Alliance, Ohio.

The introduction of electrically heated furnaces to the heating operations subsequent to melting and refining in the steel industry has experienced the slow development incident to the introduction of all radical innovations in any industry. Many of the types that will find wide application in the future, while entirely feasible, have, when offered, been met with the statement that if such an equipment was a good thing, why were they not in general use. Other types, that have been in regular service for a considerable number of years, whose construction and operation are much more elaborate and whose commercial advantages are no greater, are now generally accepted as the most rugged and reliable equipment for the purpose. This latter refers to electric furnaces for the annealing and heat treatment of steel.

One of these types installed some three years ago, and described more than two years ago in a paper before this Institute, has been used exclusively since its installation for the particular material for which it was designed—namely, cast steel draw-bar knuckles—and subsequent to the installation of the first unit, a second unit of the same capacity was installed. This equipment has, since its installation, handled over 50,000 tons of material—approximately half of all the material of this character used on American railroads having passed through these furnaces.

The higher "fuel" cost for electric furnaces over fuel fired furnaces that might have been used for the same purpose, has been amply justified in commercial practice by the labor saving effected, the precision of the treatment produced, and the elimination of the rejections of parts due to defective heat treatment; the precision of the laboratory is obtained in regular plant practice.

There has been a reluctance of manufacturers generally to consider that there is a difference in cost per ton of material put through a furnace and the cost per ton of material heat treated and coming within the specifications. There has been no greater factor in changing this attitude than the conditions brought about during the war, where in a great many plants there was a wide difference between the quantity of material inspected and the quantity of material accepted. Manufacturers now are generally conceding the justness of the higher requirements for steel, and this is one of the greatest arguments in favor of electric furnaces.

Three conspicuous examples of the electric furnace for heat treating are those for Liberty Motor crank shafts, over half of which were so heat treated; cast steel anchor chain, all of which was heat treated in furnaces of this character; and draw-bar knuckles, substantially half of those which are used in America being thus heat treated.

These examples are typical of the furnaces to be described in this paper adapted to other operations in the steel industry, and embrace soaking pits for the soaking of hot stripped ingots, re-heating furnaces for hot blooms and billets, combination fuel and electric furnaces for the heating of cold blooms and billets, recuperative car type annealing furnaces for bars and sheets, and automatic heat treating equipments for drop forgings and castings and for the heat treatment of steel rails and similar material.

The Electric Soaking Pit.

The electric soaking pit for hot ingots is perhaps the most promising development of the electric furnace to the steel maker, as the shortcomings of the present pits —whether of the fired or non-fired type—are well known, and many troubles of the rolling mill can be traced to the present type of pit.

The principal recommendation of the present type of pits, either of the fired or non-fired type, is the low fuel consumption per ton of metal soaked. This cost in a well handled pit is almost a negligible item, amounting frequently to only a few cents a ton.

However, in the larger mills, when running at full capacity, features such as lack of uniformity in temperature of the heated ingot, excessive oxidation of the ingot, and the like, are often such as to quite outweigh the item of mere fuel cost; and while it is to be admitted that electric pits cannot compete with fuel-fired pits under ordinary circumstances, when heating cold ingots, the time is not far distant when substantially all modern mills rolling hot ingots will use electric pits for this part of steel mill operation.

It has been difficult to overcome the prejudices against this innovation in ingot soaking; but the advantages to be gained are so apparent, and the success of electric furnaces in other similar fields has been so marked, that it will not be long until electric soaking pits will be in commercial operation.

From electric furnaces operating at the same temperature, or at even higher temperatures than that required in soaking pits, and which have been operating over long periods of time, it is apparent that the standby, or wall losses, of a typical pit adapted to hold sixteen 3-ton ingots will not exceed, as a maximum, 1000 K.W., and will be expected to operate on considerably less current.

However, taking 1000 K.W. as a basis, which is amply safe, and when operating on hot ingots, whose super-heated interiors are sufficient to bring to temperature their colder outer shells; and operating on a soaking time of one and one-half hours, the capacity per pit will be 32 tons per hour with a figure of 1000 K.W. current on the furnace, the current consumption

A paper read before the Iron & Steel Institute [illegible] Meeting, 1919.

per ton of metal soaked would thus be 35 K.W.H. per ton; and taking as a basis of cost of electricity in the steel mill one-half cent per kilowatt, the cost per ton of metal soaked would be 17½c, to which might be added a cost of 5c per ton for renewals and repairs, making a total cost of 22½c per ton for these two items.

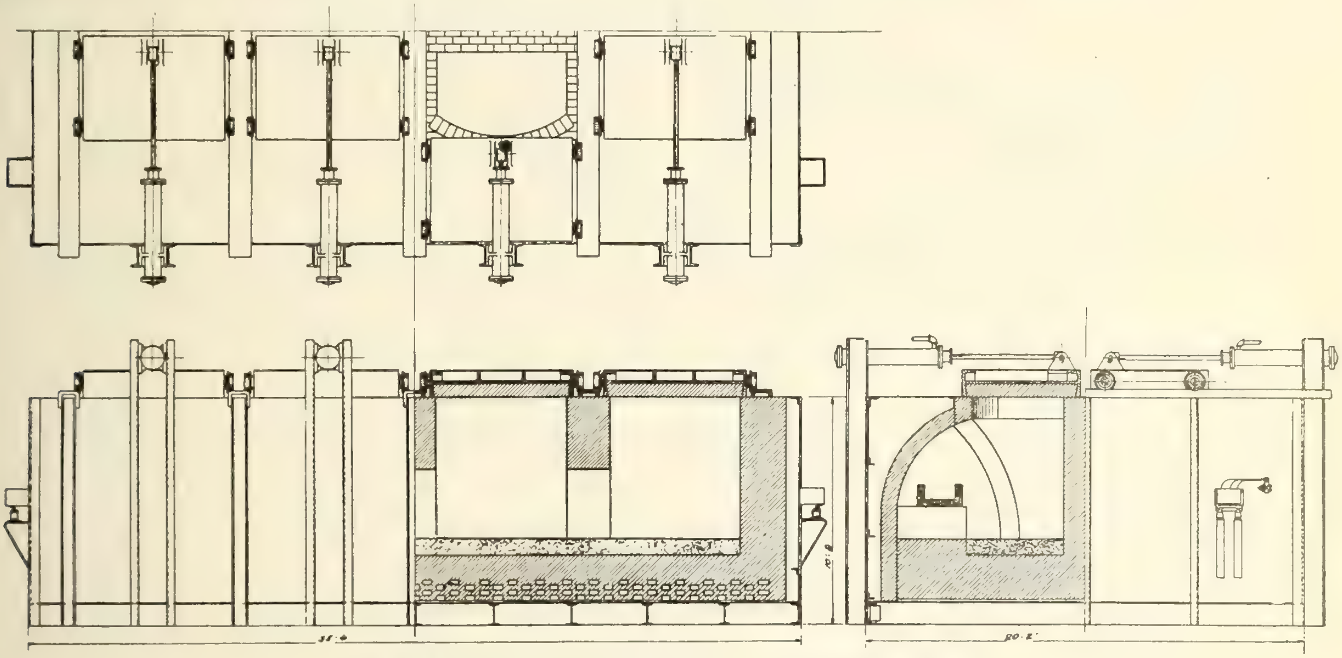
It is to be expected that this cost for heat may be in excess of similar costs for gas fired pits or unheated pits; but when taking into consideration that the electric pit will eliminate the roll breakages due to cold ingots, delays in the mill due to ingots unevenly heated, oxidation (thus producing a cleaner bloom and an actual saving in metal due to this elimination of oxidation, amounting to perhaps one-half of 1 per cent), as well as the ability of the electric pit to save labor, it is certain that the higher cost will be more than offset by the advantages, and that per ton of metal rolled in a given period the actual cost by the use of an electric pit will be less than by other means.

The accompanying slide (see Figure 1) shows the general arrangement and character of such a pit. This temperature without the addition of more heat from the pit itself, a longer time will be required by the ingots to bring them to temperature, and at the same time the capacity of the pit in tons per hour will be reduced.

But taking as a basis ingots whose average temperature would be 1800 deg. F., requiring 300 deg. additional for bringing them to temperature, the capacity of the pit would be reduced to 24 tons per hour, the electrical capacity of the pit increased to 1500 K.W., and the current consumption increased to 60 K.W.H. per ton.

With the ingots charged at an average temperature of 1500 deg. F., the capacity of the pit would be reduced to 16 tons per hour, and the current consumption increased to 90 K.W.H., without increasing the electrical capacity beyond 1500 K.W.

Thus we have for a total of heating costs, including the renewals and repairs, and with power taken at ½c per K.W.H.



Pit Type Furnace for Soaking Ingots for Heavy Gun Forgings and Ship Shafts

Fig. 1.

pit will be provided with eight holes, instead of the usual four, and in consequence only half as many ingots will be located in each cell.

The resistance elements themselves, composed, as in all furnaces of this class, of broken carbon thrown loosely into a carborundum fire-sand trough supported on brick pillars, are located along the outer wall of each side of the pit, and protected against the liability of serious accident from the ingot by being recessed some distance back from the ingot cell itself. The heat from this resistance element, it will be noted, is radiated to the circular wall of the pit, and thence to the cover, the partition wall of the pit, and to the ingots themselves. The cross section of this resistor element is such that there is very little difference between its temperature and the ruling temperature of the pit; and in actual practice most of the heating is done by the walls of the pit itself, rather than by direct radiation from the resistor element—this being of the highest importance in obtaining uniformity of heating.

In cases where the ingots cannot be delivered to the pit with enough heat for them to reach a high enough

For Hot Ingots	22½c	per ton
For Ingots at 1800 deg. F....	35	per ton
For Ingots at 1500 deg. F....	50	per ton

the final temperature in each case being taken as 2100 deg. F.

These figures can be safely taken as guarantees, and it can be expected that they will be much bettered in actual practice and operation over long periods of time.

Continuous Type Re-heating Furnaces.

It is believed that this type of furnace will find wide application in the heating of cold steel for forging and rolling in relatively small capacities, and in re-heating steel of high quality; but where very large tonnages of cold blooms or billets are to be heated, a combination fuel and electric furnace—to be later described—will be better adaptable for such work.

The accompanying slide illustrates an all-electric billet heating furnace.

This furnace was built for heating 3¼ in. round billets for shell forgings, and while the current cost for supplying this particular furnace was high, and the operating conditions not particularly favorable, never-

theless the reduction of rejections of forgings due to eccentricity, the saving of the dies due to the elimination of scale, and other advantages, such as better working conditions and simplicity of control, enabled the results to compare favorably with coal-fired practice.

This furnace was of 600 K.W. capacity, and in actual practice handled 1½ tons of steel per hour, with a current consumption of a little over 450 K.W.H. per ton, or a thermal efficiency of a little more than 50 per cent. Under more favorable conditions, an efficiency of 66 per cent, or a current consumption of approximately 300 K.W.H. per ton has been obtained. So that with low cost of current, which it is believed may be taken as ½c per kilowatt in steel mill power costs, the "fuel" cost for cold heating in units of this size would be $1.50 per ton.

This cost will compare favorably with direct coal-fired furnaces of similar capacity, and will actually show some commercial advantage, when taking into consideration the saving in metal due to scaling, which may readily run several per cent, and at least in aver-

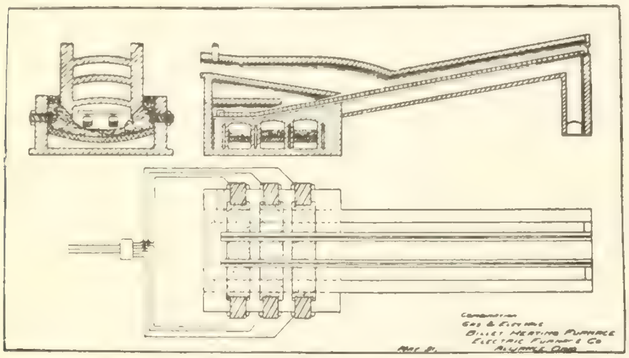


Fig. 2

age operating conditions may be taken as 2 per cent, and under the worst conditions 5 per cent, which has been actually observed in one or two instances.

Furnaces of larger capacity than the one described, of course, show a less favorable comparison to the electric, and furnaces of smaller capacity show a more advantageous comparison with the electric furnace; and it is believed that in any case, the cost of material heated in furnaces of this size, all things considered, may be safely taken as running very close together, with the electric furnace having the advantage in greater uniformity of temperature and other incidental advantages, including higher yield of good finished pieces.

An application that it is believed will find favor in certain steel mill operations is the use of an electric furnace for re-heating billets for finishing mills, wherein the blooms or billets coming from one mill are too cold to put into the finishing mill and will require approximately 200 deg. additional heat.

The calculations on such an equipment are as follows, for a capacity of 15 tons of 4 in. square billets per hour, charged into furnace at 1800 deg. F. and brought to 2000 deg. F. Such a furnace would require 800 K.W. current for its operation, and somewhat under 60 K.W.H. per ton of metal re-heated, and with ½c for power, this would make a cost of 30c per ton of metal thus re-heated. As an electric furnace of this character would undoubtedly save one-fourth of 1 per cent of metal over fuel-fired furnaces, which would amount on steel worth $40.00 per ton to a saving of 10c per ton, and then taking into consideration the low efficiency to be expected of a fuel-fired furnace of this character operating on hot billets only, there would be a decided advantage in the use of the electric furnace for such an operation.

Combination Fuel and Electric Re-Heating Furnaces.

When large tonnages of cold blooms and billets are to be heated, however, unless electricity can be obtained at an exceptionally low rate, and fuel can only be had at a high cost, a combination gas and electric furnace, such as shown in Figure 2, wherein the earlier stages of the heating up to say 1800 deg. F. are handled by fuel, and the final temperature handled electrically, is perhaps the only type that can compete with the continuous fuel-fire billet heating furnace.

Such a combination would enable the preliminary heating to be done with fuel, without the danger of excessive oxidation that is present in the fuel-fired billet heating furnace, and will insure a uniformity in the heating of the billets that is not generally obtainable in fuel-fired furnaces of this type; and while there would be a small saving of perhaps fifty pounds of coal per ton of metal heated, due to the lower temperature to which the billets are heated by the fuel-fired end, against this must be charged, say, 60 K.W.H. per ton of metal heated for the final stage by electricity; nevertheless, the advantage of uniformity in temperature, elimination of scale, etc., and more accurate control, will justify in many cases the use of such a combination furnace.

Annealing Furnaces.

Of the annealing furnaces in the steel industry, the recuperative car type will have perhaps the widest application. Two furnaces of this type are now under construction. The largest of these will have a capacity of 150 tons per day when annealing at 1200 deg. F., and is adapted for the annealing of cold-rolled strip and sheets. The second furnace, though having approximately the same dimensions, will be for annealing alloy steel bars, which require a long soaking time at maximum temperature.

The first of these furnaces is shown in Figure 3. One notable feature of these furnaces is that the annealing will be done without the usual covers required in fuel-fired furnaces ordinarily used for this work, which will constitute one of the greatest savings in annealing, as compared with present methods. This recuperative type furnace lends itself to the highest economy, as after the steel has reached the full temperature and is passing toward the discharge end of the furnace, a large part of this heat is given up to the cold incoming material.

In the preliminary trials of the first of these furnaces, excellent annealing results were obtained, as well as high economy; but difficulty was experienced with the equipment from the standpoint of complete elimination of oxidation, due to a lack of proper precaution at the ends of the furnace. This matter, however, is one readily overcome, and this equipment will soon be in regular operation.

The equipment illustrated on the slide is of 600 K.W. electrical capacity, and is approximately 225 ft. long x 22 ft. wide. The material is handed on sand-sealed cars, each car being substantially 13 ft. long x 4 ft. wide, and adapted to hold 20 tons of material, there being in all seventeen cars located on each of the two lines of track passing through the furnace, each line of cars passing in opposite directions. In the middle of the furnace is located the heating chamber proper, which is

26 ft. long, holding two cars in the heating zone on each track at a time, or substantially 80 tons of material at a time in the heating chamber.

A movement of the cars takes place on each track approximately every six hours, discharging at that time two 20-ton cars of material, one at each end of the furnace, and similarly charging at each end of the furnace a car of cold material. The cars are moved forward by means of a hydraulic machine, operated by a 600-pound water pressure system.

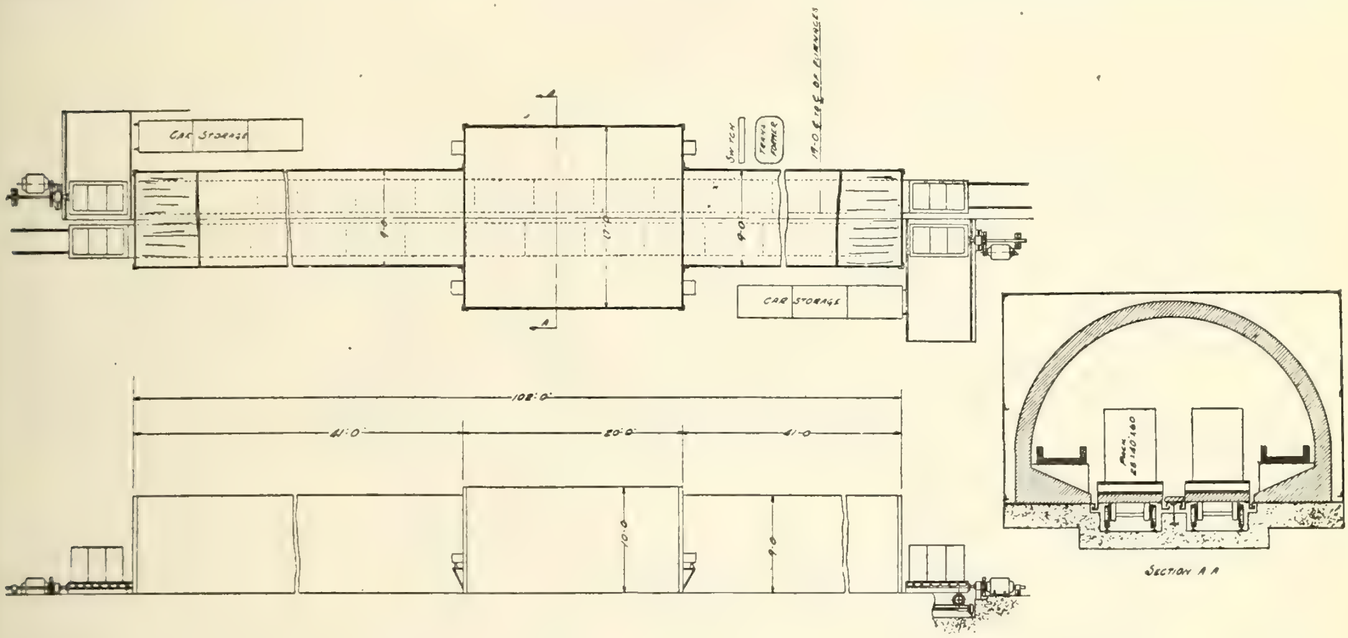
One of the requirements of this equipment is that when annealing low-carbon cold-rolled strip, the hardness should not exceed 20 sceleroscope measurement. All of the tests taken were between 18 and 19.

While no tests for maximum capacity could be taken at the time, owing to sufficient steel not being available, the operation at half capacity was well within 200 K.W.H. per ton, which clearly indicated that when operating at full capacity the current consumption would be somewhat under 120 K.W.H. per ton.

Taking again large steel mill practice of current at one-half cent per kilowatt, the cost of annealing in this zone proper. The full movement of each line of cars will take place substantially every twenty hours, delivering substantially 72 tons per day.

One of the special requirements of this furnace is that the cooling from maximum temperature over the first 200 degrees of the cooling range must not take place at a greater rapidity than ten degrees per hour. This necessitates the introduction of a very powerful and slow pulling mechanism, wherein the speed of travel does not exceed nine inches per hour.

This special equipment consists of a motor-operated chain haul, similar to the equipment used in the larger types of draw benches for tube drawing, and is supplied with a 10 H.P. motor through seven gear reductions. As the cars must pass through a sealed entrance hood or chamber before going into the furnace proper, this precaution being found necessary in order to prevent reducing the atmosphere of the furnace during charging, the pushing mechanism and the door operating mechanism are interlocked, so that when the push button starter is operated the interlocking mechanism first raises the door of the entrance hood, then the cold



Continuous Recuperative Car Type Annealing Furnace for Annealing Tin Plate, Cold Rolled Steel and Similar Material

FIG. 3.

type of furnace would not exceed 60c per ton, which will compare favorably with coal-fired annealing furnaces from a fuel standpoint, and in addition will completely eliminate the expense of covers, as well as a considerable amount of labor and will introduce a precision in annealing which it is not possible to obtain with present equipment.

The other equipment of this character, although of approximately the same dimensions, excepting being somewhat shorter in length, requires a larger heating chamber proper, even though the rated capacity is only 75 tons per day. This is due to the fact that the metallurgical requirements are such on the alloy steel to be treated that the material must be soaked for forty hours at a maximum temperature of 1400 deg. F.

The furnace itself is supplied with 800 K.W. transformer capacity, and will operate with a current consumption something under 250 K.W.H. per ton of metal annealed. In this furnace ten 15 ft. cars, each holding 30 tons of material, are located on each of the two tracks, and a maximum of 600 tons of material is in the furnace at a time, 120 tons of which are in the heating

car of material is pushed into the chamber, the entrance door closed, the door to the main furnace next opened, the pusher continuing the push of the car just far enough into the entrance hood until it comes in contact with the main line of cars in the furnace. From this point on, the travel is at the rate previously mentioned, namely nine inches per hour, during which time the door at the discharge end of the same line of cars at the opposite end of the furnace is opened, and the car at the discharge end moved into the cooling hood at that end, the discharge door on the vestibule itself still being closed. When the cold car being pulled in has come fully within the door line of the furnace proper, the door is dropped behind it and the heating chamber thus sealed.

At this point, the pushing dog behind the car is reversed, and it is returned to its starting position to bring another car into the entrance hood. While doing so, however, a pull-out chain, operated by the same shaft as the main pulling drum, latches, through means of a special dog, into the car of cooled material on the opposite track, moving it a few inches forward from the

one charge that has pushed it to the discharge position. Then the interlocking mechanism drops the door in front of the line of cars, after which the outer door of the vestibule is opened, and the drawback mechanism pulls the car entirely clear of the furnace, at which time the door of the vestibule is closed. Immediately following this operation, a similar operation to the one just described begins at the opposite end of the furnace, the chamber and the furnace proper being first opened.

Heat Treating Equipments.

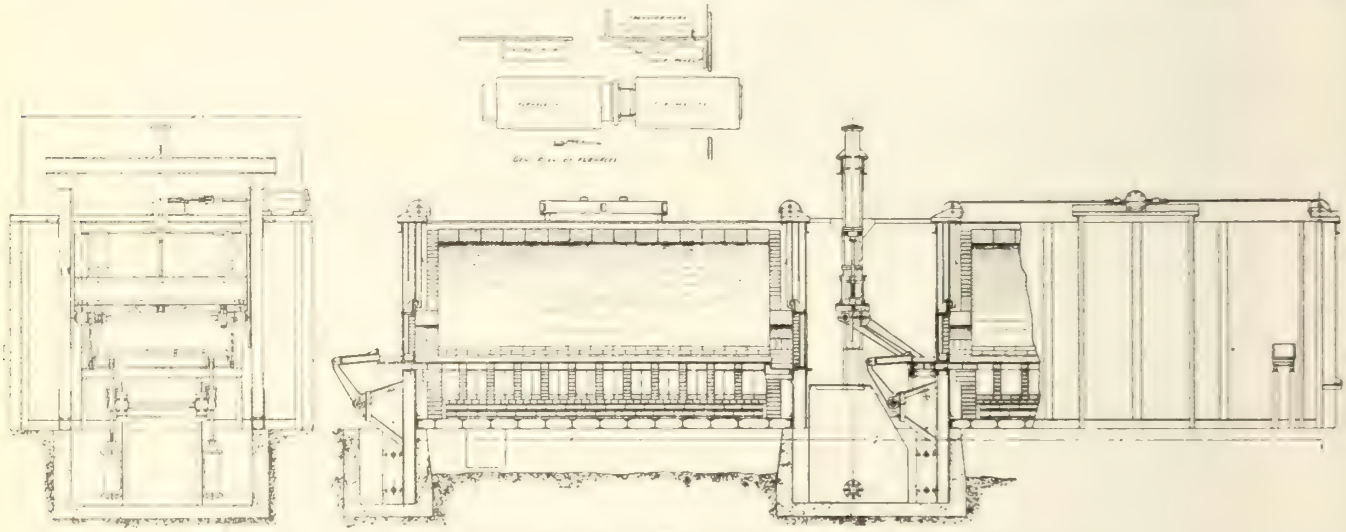
It is, however, in heat treating equipments which consist of two furnaces, one for the hardening temperature and one for the drawing temperature, in connection with a quenching mechanism located between— that electric furnaces have been first recognized as standard equipment for exacting work in the steel industry, and the earlier of these furnaces, especially of the automatic type, have been in use now for several years.

One of the most notable of these is an installation made at Sharon, Pa., over four years ago, which the following year was augmented by a duplicate installation.

Anchor Chain Heat Treating Furnaces.

A heat treating equipment of similar capacity, but with a modification as to handling mechanism, is installed at the plant of the National Malleable Castings Company, Cleveland, Ohio, for the heat treatment of cast steel anchor chain. This consists of a 600 K.W. hardening furnace, approximately 28 ft. long x 16 ft. wide, and a hearth the full length of the furnace and 6 ft. 6in. wide. At the discharge end of this furnace is located a concrete quenching tank, 40 ft. long x 8 ft. wide for quenching the chain. At the other end of this pit is a furnace of similar size, but of 300 K.W. capacity for drawing the temperature of the chain after quenching. Each of these equipments has a rated capacity of 50 tons of chain per day, and the current consumption when operating at capacity is substantially 450 K.W.H. per ton, this current consumption being 150 K.W.H per ton higher than in the other heat treating furnace just described and than the two similar sets at the same company's Sharon plant, due to the fact that the material is such that a larger furnace chamber was required for a given capacity. (See Figure 5.)

The charge of material consists of two 90-foot lengths



Continuous Automatic Two-Furnace Heat-Treating Equipment, Hydraulically Operated, for Heat-Treating Drawbar Knuckles and Airplane Cranks

FIG. 4.

A similar equipment of the same capacity was installed last year for the heat treatment of crank shafts for the 12-cylinder Liberty airplane motors. This equipment is shown in Figure 4. On account of the irregular shape of the material under treatment, and also to enable other sizes and types of airplane shafts to be handled interchangeably, a special type of cast steel chair was developed, so that the direct force of the pushers brought against a line of these chairs, the material to be heated thus lying independent and free from strain while going through the furnace.

The steel used in these crank shafts was perhaps one of the most difficult to heat treat, and the requirements were most exacting. Opportunity for obtaining the exactness of this treatment was in this case readily available, as test pieces were taken from each end of every piece, and it is interesting to note in connection with this rigid inspection that for days at a time, when producing even several hundred cranks a day, there would not be a single rejection for any cause. This fact not only speaks well for the heat treating equipment but for all the previous operations in connection with the steel, including the forging, heating for forging, and the making of the steel itself.

of 2-inch cast steel anchor chain, folded into loops 22 ft. long. These loops are drooped over heavy cast steel hooks, the ends of which, when the charge is in the furnace, protrude through recesses cut in the furnace door. The ends of these hooks are connected to a heavy steel cross bar, which is provided with lugs for fastening on the pulling chains, operated by a heavy winch, similar to a crane drum ,and equipped with a 20 H.P. motor. One of these winches is located 30 ft. beyond the discharge end of the drawing furnace, the other directly over the quenching pit.

The operation of heat treating these chains begins by dropping the loops of the folded chain over the hooks in front of the charging end of the hardening furnace, the hearth of the furnace being level with the foundry floor. The pulling chains are dragged through the hardening furnace from the front end by means of a light iron bar, the winding drum backing off the chain as it is pulled through. These chains are now hooked onto the steel cross bar of the cast steel hooks just mentioned, the winch reversed and the chain pulled into the hardening furnace, where it remains for substantially two hours, during which time it is fully and entirely heated to the furnace temperature, which is

about 1650 deg. F. The doors of the hardening furnace are then opened, and the winch pulls the chain out of the furnace into the quenching pit, where it lies on a steel frame work composed of 7-inch channels. As the chain is immersed into the quench, it is met by a strong flow of fresh water from submerged nozzles, so as to give it an initial chilling, directly as it is immersed. As the tail ends of these chains pass out of the furnace door, the door closes, and the chain is allowed to lie in the quench for several minutes. Before it is completely cooled, however, the chains from the winch of the second furnace are dragged through that furnace and hooked into the cross member and hooks holding the chain in the quench. The pulling chains from the first furnace are disconnected, the doors of the second furnace are opened and the winch of the second furnace pulls the chain into the drawing furnace, where it remains for another two hours, and is subsequently and in a similar manner withdrawn from that furnace.

Large heat treating furnaces of the automatic type such as are described in this paper, whose certainty of operation and precision of treatment have been clearly observed over several years, justify the consideration of the heat treatment of large tonnages of heavy material, such as steel rails. The building of equipments for such purposes presents no serious difficulty.

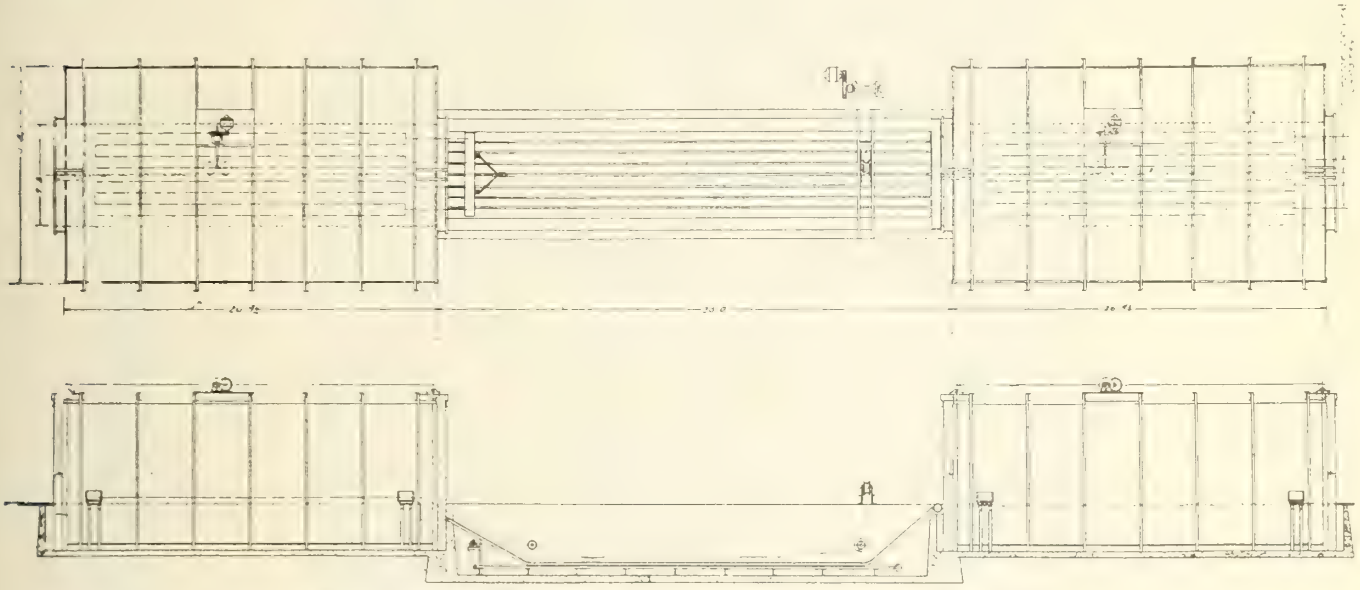
It is readily apparent to anyone interested in this subject that the heat treatment of rails is highly desirable, as the increased physical properties readily obtainable by a proper heat treatment are such as to very remarkably increase their efficiency, not only adding to the life from the standpoint of wear, but adding materially to the ultimate strength and the elastic limit, without appreciably sacrificing the ductility or toughness; and the only real question that can be raised is whether successful heat treating equipments can be found wherein every rail treated will have exactly the heat treatment specified, and whether such equipment can be rugged enough to operate with precision over long periods of time, and the cost of operation come within a reasonable commercial range.

The furnaces described in this paper, especially those of the automatic type, which have records of years of successful service, I believe fully answer the question as to precision and reliability.

As to the special requirements of an equipment for the handling of rails, this will require, of course, a rugged quenching mechanism that will prevent a 33-foot rail section from twisting during the quenching, and perhaps a similar mechanism after the drawing operation.

Such an equipment will have the advantage of complete elimination of the gag press operation now admitted to be one of the principal undesirable operations in the making of steel rails.

As to the commercial cost of the heat treating operation, as compared with the increased physical properties, it may be stated that the actual cost for electric heat under the conditions named in this paper would not exceed $1.50 per ton, and the labor cost would probably be no more, and perhaps less, than is now required in the straightening press operation above referred to. The ultimate strength of the rail would in all probability be increased more than twenty-five per cent, and the elastic limit perhaps doubled, while the life of the rail from a wearing standpoint would undoubtedly be materially increased. I believe it is a conservative statement to say that a twenty-five to fifty per cent more effective rail from a wear and safety standpoint could thus be obtained at an additional cost per ton of not to exceed five per cent.



Continuous Two-Furnace Heat-Treating Equipment for Heat-Treating Cast Steel Anchor Chain

FIG. 5.

The equipments described in the latter part of this paper are the forerunners of electric furnaces of the type that will soon come into regular use for operations on a far larger scale than will generally be conceded by the average steelmaker today, and will embrace the wide and almost exclusive use of certain types, such as the soaking pit and certain forms of the re-heating furnace first mentioned in this paper. While in some cases there will be an actual reduction in cost of operation over present methods due to the electric furnace, even for steel of average quality, the more rigid requirements in finished product will in some cases compel the use of electric furnaces.

Where requirements of the steel specified must be met, a lower cost may readily be found in operating electric furnaces, when taking into consideration the difference between the cost per ton of material put through the furnace, as compared with the cost per ton of material meeting the specifications.

Many of the arguments used against the introduction of electric furnaces were used against the introduction of large motors in the steel mills, and against electric haulage, and the statments frequently made through all the years about any innovation that "it has not been done and it cannot be done" must gradually yield, as one by one the various types of electric furnaces from heat treating equipments to soaking pits go into regular commercial and economical service.

TESTING NEW ELECTRICAL PROCESS FOR SMELTING

A test, which is causing considerable interest, is now being made to prove the commercial possibilities of smelting magnetite ore in British Columbia.

On July 9th, Mr. J. H. Fraser, managing director for the Vancouver Magnetite Iron & Steel Smelting Company, owners of the Ronaldsay Howe Sound pig-iron smelting plant, obtained from the B. C. Electric Company the use of the old power plant at Highland Station for the purpose of carrying out full tests of the Fleet process of smelting magnetite.

The Provincial Government is doing everything possible to encourage the development of the iron industry in British Columbai and has granted $2000. to carry out the test and has shipped 50 tons of Texada Island ore to be used. In addition to this the Provincial Government has agreed to pay a bonus of $3. a ton for all iron smelted in British Columbia from British Columbia properties.

Mr. Fleet declares that, by his process, which is electrical, he can produce magnetite pig-iron at from $11. to $13 a ton, this being considerably less than the oil and coke method used at the Ronaldsay plant which costs $22.

Should the Fleet process prove satisfactory a full plant will be erected and the pig-iron then handled through the Ronaldsay smelter where it can be transformed by the oil process into the best of steel. This would place Vancouver on better than a level with iron and metal industries of the East, and will help to continue on the Pacific Coast the industry of steel shipbuilding.

Mr. W. D. Fleet, of Montreal, the inventor of the process is a well known authority in electrical matters. He was superintendent of the Canadian Copper Smelting Company at Sudbury, for six years, and later installed the electrical apparatus in the big hydro-electrical plant of the Calgary Power Company at Kananaskis and Horseshoe Falls. From Alberta he went to Manitoba, where he was on the Manitoba public utilities commission. His process, which is now being tested on the iron ores of British Columbia took three years of experiment and study and is declared by men who understand smelting to be a successful one.

CHICAGO MEETING AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS

September 22 to 26 is the time set for the Chigaco meeting of the A. I. M. M. E., at which the progress that has been recently made in technical lines will be fully discussed. Among the subjects to receive particular attention will be the iron and steel industry, which has reached such importance, in Chicago. It is planned during the meeting for the Institute to make an excursion as a body to Gary, Indiana. Arrangements are being made to charter a steamer which will convey the members and guests across the south end of Lake Michigan, directly to the steel works. A tour will be made through the various departments of the steel plant, and luncheon will be served at Gary. Technical sessions on subjects in ferrous metallurgy will be held on the boat.

The banquet has been scheduled for the evening of Wednesday, the twenty-fourth, at the Congress Hotel. By putting this function in the middle of the week, it is expected that a maximum attendance can be obtained; members able to come for only a portion of the session can then be present at the banquet whether they come for the first or latter part of the week.

An elaborate programme for the entertainment of the ladies is being prepared, and all members are urged to bring their wives to this meeting.

CANADIAN IRON MEN

T. J. Brown, General Superintendent of the Nova Scotia Steel & Coal Company's operations at Sydney Mines is better known to his friends as plain "Tom Brown", a name that is singularly felicitous for one whose interest in "the boys" whether they are in their school-days, or are numbered among the employees of "Scotia", has borne fruit in the affectionate and almost proprietory regard in which he is held in Sydney Mines.

Mr. Brown was born at Low Point, not far from Sydney, Cape Breton, and has been connected with coal-mining since boyhood, and with steel-making in Cape Breton from its commencement there. Mr. Brown rose successively in positions of trust from a junior office employee of the General Mining Association to be a valued official of the Dominion Coal Company, which Company he left in 1904 to undertake the duties of his present position. With the exception of a short interval in 1918, Mr. Brown has directed operation at Sydney Mines to the present time, and has exercised his gifts of leadership through many serious crises in the history of his pioneering Company.

Not only a leader of industry has Mr. Brown excelled, but he is a mine of information regarding the early history of Nova Scotia and Cape Breton Island. A native of this Island of natural beauty and historic memories, which should be better known to Canadians, Mr. Brown has an uncanny knowledge of the glens and trout brooks that abound therein. His library contains probably the completest collection of Nova Scotiana in private hands, and some day—not too long deferred we trust—we shall have from Mr. Brown's pen a volume on the place-names of Nova Scotia which will be a real addition to Canadian litterature.

Mr. Brown is a Past-President of the Mining Society of Nova Scotia, and a Member of Council. He can always be trusted to "start something" when the proceedings of a Mining Society gathering show a tendency to lag. Recently, Mr. Brown was appointed on a special committee of the Canadian Mining Institute to consider the possible scope of a Coal Mining Section of the Institute. Incidentally, he is a happy example of that dual interest in mining and steel-manufacture that has suggested the advisability of changing the name of the Canadian Mining Institute to include the metallurgists by name, and thus avoid misunderstanding arising from ambiguity.

T. J. BROWN,

General Superintendent, Nova Scotia Steel & Coal Co., Sydney Mines, N.S.; Member of Council of the Mining Society of Nova Scotia, and recently appointed Chairman of a special committee of the Canadian Mining Institute to consider the formation of a Coal Mining Section of the Institute.

Ouebec Mines Report for 1918

Reviewed with Reference to Iron and Steel Manufacture.

The report of the Superintendent of Mines for the Province of Quebec for the year 1918 shows that a remarkable increase of materials used in the metal industries occurred in this year, chiefly attributable to war conditions. The "war-minerals" as they are termed in the Report, produced in Quebec included pyrites, chromite, asbestos, molybdenite, and until the signing of the Armistice all the deposits of these minerals large enough to be of economic importance were actively worked. "The stimulation and development which have quickened the magnesite, molybdenite and chromite industries in the Province are directly imputable to the war needs." The Report states: "The cessation of hostilities will have a depressing effect on the "mining industry. It is feared that chromite mining "will decrease to a small fraction of what it has been "in the last three years. Already the number of "operators in the Coleraine field has dwindled down "from twelve in August 1918, to two in March 1909.

"It is hoped", says the Report, and the hope does not seem an unreasonable one, "that the magnesite "industry received a sufficient impetus during the "war to now stand on its own merits. The consumers "who have used Quebec magnesite, raw, or dead-burn-"ed, are thoroughly satisfied with the results obtained.

The following table, reproduced from the Report, shows in millions of dollars the relative importance of the three main divisions of the mineral production of the Province, and illustrates clearly the effect of the war thereon.

Substances Produced

	1913	1918
Building materials: stone, lime, brick, cement	8	5½
Non-metallic minerals: asbestos, magnesite, mica, graphite, etc.	4½	10¼
Metallic minerals: pyrites, copper, chromite, molybdenite, lead and zinc	½	3
Totals	13	18¾

The following figures of production are selected from the Report as being of interest to the steel industry, the value of the 1917 output being given for comparison:

	Tons	Value	Value in 1917
Chromite	36,131	770,955	498,031
Iron and titaniferous iron ores	6,860	33,726	54,135
Magnesite	28,654	1,016,764	729,025
Molybdenite (lbs.)	342,296	383,252	238,096
Quartz and Silica	23,286	61,669	32,511

In connection with the chromite mining industry, the Report states:

"As to value, the year 1918 constitutes a record which will not be reached again for a long time, unless some new unexpected sources come to light. As explained in last year's report, the world's usual sources of supply or chromite, Rhodesia and New Caledonia, were practically cut off as far as America was concerned, owing to the lack of ocean shipping space. The United States and Canada had to develop their own resources in that mineral to supply their needs, which an estimate had put at 160,000 tons for the year 1918. An appeal was made to all owners of chromite deposits to do all they could to produce as much as possible. In consequence the prices rose gradually until in May and June the quotations were $1.50 to $1.55 a unit for 45% ore with variations of 5c. a unit for grades above or below that standard. These prices were F. O. B. at shipping points. In the United States transactions were recorded at $100 a ton for 50% ore. By September the prices had eased off considerably to $1.40 and less, while in October the market could not absorb the supply. On the news of the signing of the armistice the bottom practically dropped out of the chrome market, and at the end of the year only the operators having contracts to fill at prices which permitted to make ends meet were working. At present, in March 1919, only two operators are producing. It may be stated in a general way, that under the present conditions, chrome mining to be remunerative in the Province of Quebec requires a market price of 80c. to $1.00 a unit for 45% shipping ore or concentrates."

As an example of what can be done when home products are rendered valuable by inability to obtain them from abroad, the Report mentions that at the request of the United States Government, the production of chrome was stimulated in every possible way by the Canadian War Trade Board, who appointed Dr. Robert Harvie, with headquarters at Black Lake as the representative of the Board. The policy followed to attain an increased production was to improve existing facilities and to give direct assistance whenever possible, such as speedy granting of export and import licenses, the waiving of express regulations to facilitate delivery of machinery, obtaining military exemptions for skilled employees and improvements in freight-car service. A record of Dr. Harvie's work was contributed to the Engineering & Mining Journal, and is quoted from in the Report as follows:

"From 1894 to 1908 a steady production was made by the Black Lake district, and from 1903 to 1907 it was sufficiently great to give Canada either third or fourth place among the world's producers of chromite. In 1909 production declined to zero, owing to the impossibility of meeting the competition from the larger, richer deposits in Rhodesia and New Caledonia. There was no production from 1909 to 1914. In 1915, the rising freight rates on ocean shipments of chrome ore, reached such a level that the correspondingly rising prices offered for chrome ore attained a figure at which Canadian deposits could once more be profitably worked. The following table indicates the renewal of activity in what had been a dormant industry in Canada. Incidentally, the figures admirably illustrate the influence of increased prices in bringing out supplies and stimulating production.

Canadian Chrome Shipments, 1894-1918

	Short tons	Total Value	Average Value per ton
Total prior to 1914	62,334	$716,400	$11.29
From old stock, 1914	136	1,210	8.90
Shipments for 1915	12,341	179,543	14.55
Shipments for 1916	15,412	312,901	20.35
Shipments for 1917	23,327	572,155	24.50
Shipments for 1918	21,200	800,000	38.00

With regard to molydenum and the future probable

consumption, the Report says it is difficult to obtain reliable information, and even the uses to which this mineral has been put during the war are only vaguely ascertained. The Report states further:

The chief use of molybdenite is in the manufactnre of ferro-molybdenum, which enters into the composition of high-speed tool steels, molybdenum tool steel possessing the same qualities as tungsten steel. The main objection to substituting molybdenum for tungsten in the manufacture of self-hardening tool steel is that to give satisfactory results, great care and skill are required in observing the proper proportions and in the annealing process. It requires about three times less molybdenum than tungsten to obtain the same effects in the tool steel, but molybdenum steel is much more liable to crack, or otherwise deteriorate in careless quenching.

Molybdenite is also used in the manufacture of chemicals, ammonium molybdate, sodium molybdate, molybdic acid.

Apart from these uses the technology of molybdenum is more or less obscure. A short time before the declaration of war, prices for molybdenite rose steadily until in 1914 it attained $3.00 and $4.00 a lb. It is surmised that this rise was due to German buyers securing stocks as a substitute for tungsten. Other uses to which molybdenum and molybdenum compounds are said to have been put to a great extent, but most of which have been alternately denied and reiterated. are manufacture of smokeless powder, stabilizer for high explosives, to prevent their decomposition and spontaneous explosion; special steels for gun linings and for rifle barrels; armour plates and manufacture of plate-piercing projectiles. Enquiries made by the United States Geological Survey from the military authorities of the Allies brought forth the fact that none of the war material manufacturers of the United States, France or England were using molybdenum in armour plates or large guns, and that numerous analysis of captured German guns showed that it was not being used by the Germans.

The French, however, used molybdenum in the manufacture of the breech blocks of some of their field guns. The alloy "stellite" may also contain a small proportion of molybdenum. The original "stellite" is an alloy of cobalt 50 to 60% chromium 30 to 40%, tungsten 8 to 20%. Sometimes part of the tungsten is replaced by molybdenum. A small proportion of molybdenum, less than one per cent, has also been used in the steel of some of the crank shafts and connecting rods of the "Liberty" motors for aircrafts, built for the United States War Department."

References made to an occurrence of scheelite in the township of Marlow, Beauce County, but it does not appear to be of importance.

Very considerable space is devoted in the Report to the magnesite industry, which has now assumed, it is to be hoped, a permanent importance in Quebec. The position of Quebec magnesite was summed up succinctly in an article by M. E. Wilson, of the Geological Survey, which appeared in the "Canadian Mining Journal" in January 1919. Dr. Wilson stated: "Quebec magnesite is stated by the metallurgists who have "used it to be fully equal to the Austrian or the Grecian product, although these are much lower in lime. The general prejudice against dead-burned magnesite high in lime should be revised, for it is only when this is present as free lime that it is harmful. The "careful preparation of the Grenville magnesite, its "thorough mixing with the necessary amount of iron-"ore, its clinkering at the high temperature of 1650 "degrees to 1700 degrees C. in rotary kilns, ensure a "product which meets the requirements of the most "exacting metallurgists."

There is some dubiety as to whether the iron and steel industry in Canada can ever hope to be thoroughly self-supporting in the matter of iron-ore and perhaps also in the matter of coal, but here is one necessary material that can be produced at home, and it is to be hoped that Dr. Denis's modest hope for the survival of the magnesite industry in Quebec will be fulfilled.

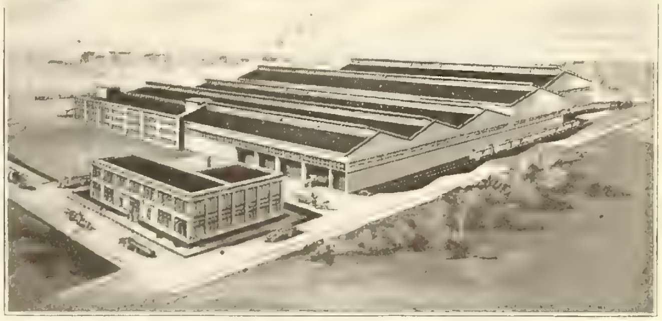
There is no detailed mention of the iron-ore and titaniferous ores in the Province, but reference to previous reports shows that the industry was partially revived during the war, but that in 1918 the production was 6,860 tons against 17,150 tons in 1917, so that in Quebec, as in all the other provinces of Canada, the production of native iron-ores is disappointing and meagre.

The Report is well arranged, and very readable. A warning to the investing public against "wild-cats" is timely and quite proper in a Province which has as a metropolis, if not as a capital, such a nursery for "wild-cats" as Montreal, if one is to judge by the advertisements of mining ventures which are admitted into the columns of the newspapers published in that City.

—F. W. G.

THE J. T. RYERSON STEEL-SERVICE PLANT AT DETROIT

The J. T. Ryerson Company of Detroit in its "steel-service" plant in Detroit has carried modern steel-wholesaling methods to much perfection.



The Plant, which has a floor-space of 122,000 feet, consists of seven steel-construction bays, 60 feet span and 330 feet in length. The buildings are bounded on one side by the Grand Trunk and on the other side by the Michigan Central Railways. This arrangement gives much facility for quick handling of material, and a train-load of steel can be taken care of at one time. As the material is unloaded at either end of a span, it is stacked and piled in the proper bins according to size, and, as orders require, the steel is picked up and delivered in the main aisles. From the aisles the steel is conveyed by a fleet of five-ton trucks, which deliver the material at the purchaser's door.

In addition to the regular handling equipment, each bay has installed in a prominent position such cutting tools as heavy plate shears, sheet shears, high-speed saw and angle and bar shears. Shapes can be cut to any size desired.

Effect of Time and Temperature on Physical Properties of Medium-Carbon Steel[1]

By G. A. REINHARDT[2] and H. L. CUTLER[3]
Youngstown, Ohio

The Youngstown Sheet & Tube Co. has produced a large tonnage of 0.35 to 0.45 carbon forging steel, the acceptance of which was based on the physical properties of test specimens obtained by forging the original 5¾ in. (14.5 cm.) square bloom to a ¾ in. (1.9 cm.) round. Annealed by heating from 900 deg. to 950 deg. C. and cooling slowly in mica. The test bars were tempered by heating to 825 deg. to 875 deg. C. quenching in water, and drawing to 515 deg. to 535 deg. C. Immediately after heat treatment, the test pieces were machined to a diameter of 0.534 in. (1.38 c.m) and tested. Very good physical properties were obtained and no difficulty was experienced in meeting the specifications called for.

	Ultimated Strength Lb. per Sq. In.	Elongation, Per cent in 4 in Not less than
Annealed specimen ..	78,230 to 92,450	18
Tempered	10,000 to 149,350	9

After experience on this material, production of slightly higher carbon forging steel was started. The method of testing this material required that test blooms be either normalized or annealed. The normalizing consisted in heating to 850 deg. to 900 deg. C. and cooling in still air; the annealing, in heating to 850 deg. to 900 deg. C. and cooling in the furnace or in mica. From the treated bloom, the test pieces were taken either by core drilling or by sawing from points midway between the edges and the intersection of the diagonals. The cores or blocks were turned to a standard 2-in. test piece with a diameter of 0.564 in. and tested without further treatment. The physical requirements of the test pieces were:

Yield Point, Lb. per sq. in. Minimum.	Ultimate Strength, Lb. per sq. in.	Elongation % in 2 in. not less than
44,800	89,600 to 112,000	17

Difficulty was encountered as soon as work on this material was started. Many precautions and refinements were instituted but it was found very difficult to secure the required elongation.

Steel of very good chemical analysis was produced and great care was taken during the heating and rolling. A muffle furnace was equipped with rare-metal pyrometers to secure accurate heat treatment. The test pieces were turned with care so that in testing a straight pull was obtained. None of these precautions seemed to produce the desired results, although occasionally the results were very good. A careful examination disclosed the fact that invariably these occasional results were obtained from test pieces that had been machined the day before they were tested.

Mr. I. C. Mackie, chief chemist of the Dominion Iron & Steel Co., said that he had encountered similar conditions with rail steel so that a practice had been developed to rest all rail steel test specimens for a period of at least 12 hr. before testing.An employee of the metallulgical department of The Youngstown Sheet & Tube Co., who had previously been in charge of a rail mill, reported a similar experience with rail steel. As a result experiences and suggestions, all test pieces were rested over night and tested the following day. With this practice no difficulty was experienced in meeting the elongation requirement of the specification. Frequently it was a misadvantage to hold a shipment long enough to afford a 24-hr. rest for the test pieces. So experiments were made that showed that a rest of a few hours at about 120 deg. C. was equal to a rest of 24-hr. at room temperature.

A series of tests was then made to determine the

TABLE 1.—*Results of First Series of Tests*

Heat No.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elongation, Per Cent in 2 In.	Reduction of Area	Analysis C	Mn	S	P	Treatment
A-9	61,[illegible]	[illegible]7,200	10.0	12.6	0.53	0.75	0.034	0.050	
	58,370	[illegible]	11.0	13.4					
Aver.	60,[illegible]	[illegible]	10.5	13.0					Rested 2 days at room temp
	[illegible]	109,100	15.5	21.1					
	[illegible]7,250	[illegible]	17.0	22.4					
Aver.	[illegible]	109,050	16.25	21.8					Rested 2 days on furnace (120° C.)
	[illegible]	88,120	21.0	[illegible]					Heated at 850° C.; 2 hr., cooled in mica
B-33	[illegible]	[illegible]	11.0	13.4	0.58	0.58	0.033	0.030	
	58,450	103,600	11.0	14.4					
Aver.	57,[illegible]	[illegible]	11.0	13.9					Rested 2 days at room temp
	[illegible]	105,200	16.0	18.9					
	60,[illegible]	107,000	14.5	16.9					
Aver.	[illegible]	106,100	15.25	17.9					Rested 2 days on furnace (120° C.)
	45,520	86,550	21.5	[illegible]					Heated at 850° C.; 1½ hr., cooled in mica
C-11	[illegible]	95,150	14.5	18.2	0.49	0.69	0.032	0.011	
	56,570	96,500	14.0	16.7					
Aver.	55,480	95,820	14.25	17.4					Rested 2 days at room temp
	[illegible]	100,800	17.0	22.0					
	[illegible]	97,440	21.0	[illegible]					
Aver.	[illegible]	99,120	19.0	[illegible]					Rested 2 days on furnace (120° C.)
	50,720	94,000	[illegible]	[illegible]					Heated at 850° C.; 1¾ hr., cooled under cover
C-30	55,040	95,800	14.5	[illegible]	0.50	[illegible]	[illegible]	0.039	
	53,800	[illegible]	12.5	17.6					
Aver.	54,420	95,660	[illegible]	[illegible]					Rested 2 days at room temp
	56,450	101,600	[illegible]	[illegible]					
	[illegible]	98,400	18.5	28.1					
Aver.	[illegible]	100,000	[illegible]	27.2					Rested 2 days on furnace (120° C.)
	[illegible]	94,160	[illegible]	[illegible]					Heated at 850° C.; 1¾ hr., cooled under cover
D-30	[illegible]	105,100	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
	57,850	[illegible]	[illegible]	10.0					
Aver.	56,540	104,750	[illegible]	[illegible]					Rested 2 days at room temp
	[illegible]	[illegible]	15.0	[illegible]					
	[illegible]	107,500	11.0	[illegible]					
Aver.	[illegible]	[illegible]	[illegible]	16.7					Rested 2 days on furnace (120° C.)
	[illegible]	[illegible]	17.5	[illegible]					Heated at 870° C.; 1⅝ hr., cooled in mica

[1] A paper read before the American Institute of Mining and Metallurgy to be presented at Chicago in September 1919.

[2] Metallurgist, The Youngstown Sheet and Tube Co.

[3] Assistant Metallurgist, The Youngstown Sheet and Tube Co.

cause for the great difference in elongation and reduction of area shown by core tests made directly after drilling and machining, and core tests made on material that had rested after drilling and machining. While this cause was not found, some interesting data was collected before it was necessary to discontinue the investigation, and it is the purpose of this report to present that data.

In the first series of tests, four cores were drilled from each of six untreated blooms; i.e., blooms direct from the blooming mill. Two cores from each bloom, after machining were rested two days at room temperature before testing. The two duplicate cores after machining were rested two days on top of a Hoskins hair-pin type electric furnace where the temperature was about 120 deg. C. There is also reported the physical properties of a core from an adjacent piece of the same bloom which had received the heat treatment shown. The machined test piece had rested approximately 12 hr. on top of the Hoskins furnace. The results are given in Table 1.

A second series of tests was made in identically the same manner except that, after machining, a rest of four days was given the test pieces before testing. The results are given in Table 2.

TABLE 2.—*Results of Second Series of Tests*

Heat No.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elongation, Per Cent in 2 In.	Reduction of Area	Analysis C	Mn	S	P	Treatment
E-8	52,880	101,000	10.5	11.4	0.50	0.67	0.040	0.023	
	49,060	101,500	9.5	10.0					
Aver.	50,970	101,250	10.0	10.7					Rested 4 days at room temp.
	52,080	103,000	17.0	24.2					
	51,110	103,400	17.0	25.8					
Aver.	51,590	103,200	17.0	25.0					Rested 4 days on furnace (120° C.).
	49,720	97,000	22.5	38.3					Heated at 850° C.; 1½ hr., cooled in air.
L-25	51,160	93,400	16.0	22.7	0.49	0.55	0.037	0.017	
	51,640	93,240	16.0	11.3					
Aver.	51,400	93,320	16.0	17.0					Rested 4 days at room temp.
	49,360	93,260	22.0	33.9					
	49,320	94,180	19.0	30.6					
Aver.	49,340	93,720	20.5	32.3					Rested 4 days on furnace (120° C.).
	49,280	93,260	23.5	37.5					Heated at 850° C.; 1½ hr., cooled in air.
F-10	51,560	97,680	11.5	13.0	0.50	0.64	0.037	0.018	
	51,760	97,140	12.0	14.0					
Aver.	51,660	97,410	11.75	13.5					Rested 4 days at room temp.
	49,560	97,520	17.5	24.2					
	50,880	100,500	16.0	24.5					
Aver.	50,220	99,010	16.75	24.4					Rested 4 days on furnace (120° C.)
	48,640	94,760	24.0	39.7					Heated at 850° C.; 1½ hr., cooled in air.
F-10	51,080	96,920	12.0	13.4	0.49	0.60	0.039	0.018	
	49,640	96,400	11.0	13.7					
	50,360	96,660	11.5	13.6					Rested 4 days at room temp.
	50,600	98,400	16.0	21.1					
	53,440	98,480	17.5	22.7					
Aver.	52,020	98,440	16.75	21.9					Rested 4 days on furnace (120° C.)
	53,050	92,500	25.0	39.0					Heated at 850° C.; 1½ hr., cooled in air.

These two series of tests showed that a slight increase in temperature resulted in a great improvement of elongation and reduction of area. There is a general increase in the tensile strength, which, however, was greater in the case of a two day's rest than in the case of a four day's rest.

From adjacent blocks of one bloom, eight core tests were taken and machined at different rates to determine the effect of the speed of machining. Four of the cores were machined at the usual rate and four with very light cuts and at very slow speed. Two of the cores machined as usual and two of the cores machined very slowly were pulled immediately after the machining operation. The four other cores were rest-

TABLE 3.—*Tests on Adjacent Blocks of One Bloom*

Heat No.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elongation, Per Cent. in 2 In.	Reduction of Area	Analysis C	Mn	S	P	Treatment
G-10	53,600	93,700	18.5	27.9	0.49	0.66	0.041	0.014	
	54,300	94,000	18.5	25.8					
Aver...	53,950	93,850	18.5	26.8					Machined as usual, tested immediately.
	54,510	94,080	23.0	44.1					
	53,560	93,800	24.0	39.7					
Aver...	54,030	93,940	23.5	41.9					Machined as usual, rested on furnace 20 hr.
	55,400	93,500	19.0	26.8					
	54,700	94,300	18.5	26.6					
Aver...	55,050	93,900	18.75	26.7					Machined slowly, tested immediately.
	54,160	93,260	24.0	40.0					
	53,920	92,640	23.5	39.7					
Aver...	54,040	92,950	23.75	39.8					Machined slowly, rested on furnace 20 hr.

ed 24 hr. on top of the electric furnace and then tested. The results, given in Table 3, show no difference in elongation, reduction of area, and tensile strength, between the pieces that were machined as usual and those that were very slowly machined. This indicated that the rate of machining exerts practically no influence on the physical properties.

Sixteen core tests were taken from four adjacent blocks of one bloom. Six cores were machined immediately after core drilling. Two of these six cores were tested immediately after machining; two were rested on the furnace 24 hr. before testing, and two were rested 100 hr. on the furnace before testing. Two rough cores were held four days, then heated for 2 hr. in the tin bath at from 490 deg. to 500 deg. C. They were then machined and tested immediately after machining. Four rough cores were held at room temperature for 16 days. Two of the cores were then machined and tested immediately after machining. The other two cores were heated in the tin bath at 595 deg. to 605 deg. C. for 2 hr. and then machined and tested immediately after machining. Four rough cores were heated to 900 deg, C., held 45 min., cooled

TABLE 4.—*Tests on Four Adjacent Blocks of One Bloom*

Heat No.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Elongation, Per Cent. in 2 In.	Reduction of Area	Analysis C	Mn	S	P	Treatment
H-11	51,300	96,400	14.5	18.2	0.48	0.66	0.042	0.028	
	49,300	94,800	14.5	18.9					
Aver..	50,300	95,600	14.5	18.5					Cores machined immediately, tested immediately after machining.
	51,410	97,520	21.0	37.2					
	52,170	96,360	21.0	34.5					
Aver..	51,790	96,840	21.0	35.8					Cores machined immediately, tested after resting on furnace 25 hr.
	52,460	93,660	23.0	32.5					
	55,490	92,950	23.0	36.6					
Aver..	53,970	93,300	23.0	34.5					Cores machined immediately, tested after resting on furnace 100 hr.
	56,130	94,080	20.0	26.1					
	60,670	95,900	19.5	26.1					
Aver..	58,400	94,990	19.75	26.1					Cores held 4 days, heated in tin pot 490–500° C. 2 hr., machined, and tested immediately.
	49,600	93,480	21.7	32.0					
	49,280	94,880	21.0	32.0					
Aver	49,440	94,180	21.35	32.0					Cores held 16 days, machined, and tested immediately.
	50,840	94,440	20.5	31.7					
		94,760	20.0	30.1					
Aver	50,840	94,600	20.25	30.9					Cores held 16 days, heated in tin pot 595–605° C. 2 hr., machined, and tested immediately.
	48,000	91,300	22.0	35.5					
	47,300	90,400	22.5	35.2					
Aver	47,650	90,850	22.25	35.4					Core annealed 900° C., 45 min. Cooled in thin mica, tested immediately after machining.
	47,840	89,720	23.5	35.7					
	49,260	90,800	23.5	36.0					
Aver	48,550	90,260	23.5	35.8					Core annealed 900° C., 45 min machined, rested 25 hr. on furnace.

in thin mica, and then machined. Two were tested immediately after machining and the other two were rested 25 hr. on the furnace before testing.

The results of the tests made on the 16 cores, given in Table 4, show that the elongation increased with increased length of rest at the temperature of the top of the furnace. A rest of 16 days at room temperature increased the elongation and reduction of area about the same extent as a rest of 25 hr. on the electric furnace. This comparison is not entirely accurate, for the tests that were rested 16 days were machined after the rest while the tests that were rested 25 hr. had been machined before the rest. Previously reported tests have indicated, however, that the effect of the machining operation is slight, so the comparison is justified. The tests that were heated to 500 deg. C. and 600 deg. C. after rests of 4 and 16 days, respectively, and then tested immediately after machining, gave lower elongation and reduction of area values than tests that had been rested at lower temperatures. This is difficult to explain, as it is not considered that stresses are induced in the test piece by the air-cooling from temperatures as low as 500 deg. C. and 600 deg. C. The tests on the annealed cores that were rested on the furnace for 25 hr. after machining gave slightly better elongation values than the tests pulled immediately after machining. The difference is slight and supports the opinion that the influence of the usual machining operation is very little.

Five cores that had remained in the laboratory for 207 and 208 days at normal room temperature were machined and tested immediately after machining. The results obtained from these tests are given in comparison with the results obtained on cores from the same blooms that had been tested soon after core drilling and machining. These results given in Table 5 show a decided improvement in elongation and reduction of area.

TABLE 5.—*Tests on Cores 207 Days Old*

Cores Rested, Then Machined and Tested Immediately					Original Test Made Shortly After Drilling and Machining		
Yield Point, Lb per Sq In	Ultimate Strength, Lb per Sq In	Elongation, Per Cent in 2 In.	Reduction, of Area	Number of Days Machined Bar Rested	Ultimate Strength, Lb per Sq In	Elongation, Per Cent, in 2 In.	Reduction of Area
52,320	102,600	19 0	30 6	208	101,100	13 5	14 7
54,480	102,600	19 0	30 6	208	99,900	13.5	15.7
...	103,300	19 0	29 5	208	101,900	14.0	17 0
54,640	101,300	21 5	35 2	207	101,300	16 5	19 9
54,720	101,600	21.5	36 4	207	102,600	15 0	17.3

A number of machined test pieces had remained in the laboratory from 36 to 68 days. These test pieces were tested and the results obtained compared with the results obtained on tests from the same blooms that had been tested soon after the drilling and machining operations. The exact data on earlier tests were not available, as the tests were a part of the routine testing and the times drilled, machined, and pulled were not recorded. These results given in Table 6 also indicate a considerable improvement in the elongation for the rested test pieces.

TABLE 6.—*Tests on Cores 1 to 2 Months Old*

Cores Machined Immediately After Drilling, Tested After Resting at Room Temperature					Original Test Made Shortly After Drilling and Machining		
Yield Point, Lb per Sq. In.	Ultimate Strength, Lb per Sq In	Elongation, Per Cent In 2 in	Reduction of Area	Number of Days Machined Bar Rested	Ultimate Strength, Lb per Sq In	Elongation, Per Cent in 2 In.	Reduction, of Area
51,420	106,700	21 0	31 4	68	101,840	11 0	
52,320	96,720	20 5	28 5	47	93,850	18 0	
50,550	93,010	23 0	37 2	50	92,350	16 0	
51,880	96,960	21 0	28 7	41	96,640	15 0	
57,160	91,030	25 5	42 4	41	90,760	20 0	
52,960	94,600	25 0	39 7	41	89,720	17 0	
52,840	89,480	25 5	41 9	36	91,810	21 0	
51,920	88,600	25 0	37 2	41	92,000	21 5	
56,540	96,270	23 0	33 2	40	94,500	16 0	
49,780	89,240	21 0	36 7	50	87,750	21 0	
53,720	94,540	22 0	30 9	62	94,040	14 5	

Ingots of the same size and chemical composition as those used in the foregoing jets were rolled on the blooming mill and immediately rolled on the continuous mill to $1\frac{7}{8}$-in. (4.7-c.m.) square billets. From these billets standard test pieces were turned. Some specimen were tested immediately after machining operation, others were tested after resting for different lengths of time at room temperature, still other duplicate sets were tested after resting at slightly elevated temperatures for the same lengths of time as those at room temperature. Identical results were obtained from the three sets of tests. The average result of tests pulled immediately after machining, the average result of tests pulled after different lengths of rest at room temperature, and the average result of tests pulled after different lengths of rests of slightly elevated temperatures were in close agreement with one another. This series of tests indicated that the size of the finished rolled product, bloom, or billet has an important effect on the physical properties of tests specimens taken from that product and tested with no subsequent treatment except resting.

Summary

The tests made on blooms indicate that the poor elongation of the tests made immediately after the drilling and the machining is not due to the machining operation to any great extent.

The ductility of the steel expressed by elongation is greatly improved by some equilibrium adjustment, which takes place slowly at room temperature and much more rapidly at slightly increased temperature.

It seems possible that the difference in the results obtained on tests taken from blooms and on tests taken from small billets may be due to a combination of solidification and rolling strains.

TRANSVAAL IRONWORKS

Smelting Now In Progress Near Pretoria

The smelting of native iron ore in South Africa is now being carried out by the Pretoria Iron Mines (Limited) at their blast furnace near the administrative capital of the Union.

The ore used is a mixture of siliceous and clay-band ores from the lower portion of the Pretoria series. This siliceous ores is an arenaceous oolitic ironstone in which most of the iron is present as martite, assaying from 40 to 54 per cent. of iron. The clay-band ore contains from 50 to 55 per cen. of iron. The supply is practically inexhaustible. The ore is mined only a few hundred yards from the works and the coal used comes from Natal. Limestone is obtained from Taungs and also from a quarry about six miles from Pretoria.

The scale of operations is small at present but in view of the large demands of the local market for good quality pig-iron there should be ample possibility of expansion.

ANYOX BY-PRODUCTS OVENS IN OPERATION

The by-product coke-ovens of the Granby Consolidated Mining, Smelting & Power Company at Anyox were placed into operation on July 11th, and coke of excellent quality is understood to have been produced. The coal used comes from the Granby Company's colliery at Cassidy, Vancouver Island.

COMPANY NOTES

Dominion Steel Corporation

Construction work on the plate mill has been resumed following the conclusion of a revised price agreement with the Federal Government.

The effect of business conditions is shown in the announcement that the producing operations at the Sydney Plant are to be temporarily suspended, and that advantage will be taken of the lull to effect general plant repairs. Commenting on this situation, the Montreal "Gazette" says that business has not been of the satisfactory nature hoped for earlier in the year, but that a factor of probably greater importance is the attitude of labour as it affects the big Sydney enterprise. "That this has been uncertain "and unsatisfactory is common knowledge, and it is "believed in local circles that the contemplated action "of the Executive in respect to what will virtually "be a closing down of the Sydney Plant is largely "the result of such a state of affairs. Labour must "make up its mind about what it wants and what it "is willing to do before the selling branch of the "enterprise may intellingently and profitably seek a "market for the output of the mills."

Nova Scotia Steel & Coal Co.

Productive operations are suspended at the Sydney Mines Plant, and extensive repairs are being made to the furnaces, including a re-lining of the blast furnace, which has been in constant and satisfactory operation for the period exceeding five years without re-lining.

At New Glasgow, the works and car-works are operating at about 75 per cent capacity.

The Nova Scotia Company has acquired the coal-loading plant of the British Ministry of Shipping on the Terminal Wharf of the Canadian National Railways, at Halifax. This plant is modern and during the war has made some excellent performances in coaling the large ships that have been used to transport troops and war-material from Halifax. The acquisition of this plant will make the Scotia Company an important factor in the bunkering business in Halifax, particularly in the supplying of the larger ocean liners. The importance of Halifax as a port, and as ship-building and ship-repair station is growing. The war merely demonstrated the possibilities of Halifax, but its greatness lies in the future.

Ontario Steel Products Company.

The annual financial statement of the Ontario Steel Products Company shows that the Company has maintained the average of the previous two years.

Net profits amounted to $198,770 as against $208,107 in 1918 and $182,295 in 1917. After deducting bond interest of $36,000 preferred dividends including arrears paid of $73,125, and sinking fund write off of $12,000, surplus amounted to $77,645, as against $98,232 in 1918 and $60,420 in 1917. This added to surplus carried forward from the previous year balance at credit of profit and loss account at the end of the fiscal year at June 30 to $359,374 compared with $281,729 in 1918 and $183,497 in 1917.

Profit and loss account compares as follows:

	1919	1918	1917
Net	$198,770	$208,107	$182,295
Bd. int.	36,000	36,000	36,000
Pfd. divids.	73,125	61,875	61,875
Sink. fund.	12,000	12,000	12,000
Surplus	$ 77,645	$ 98,232	$ 60,420
Prev.* surpl	281,729	183,497	123,077
	$359,374	$281,729	$183,497

(*)—Inc. arrears paid.

Balance sheet compares as follows:

Assets.

	1919	1918
Real Est.	$1,870,020	$1,848,559
Cash	108,831	129,648
Bills and acts. rec.	319,302	231,787
Inventories	236,599	272,971
Securities	160,956	80,041
Insurance adv.	2,657	2,392
Current assets	$ 825,688	$ 714,447
Total assets	$2,698,366	$2,565,398

Liabilities

	1919	1918
Preferred stock	$ 750,000	$ 750,000
Common stock	750,000	750,000
Bonded debt	538,200	561,300
Reserves	148,751	138,516
Bills and act. pay	78,680	66,753
Profits tax	34,234	......
Bond interest	16,626	17,100
Preferred dividend	22,500	......
Current liabilities	$ 152,041	$ 83,853
Total liabilities	$2,698,366	$2,565,398

Working Capital

	1919	1918
Current assets	$825,688	$714.447
Current liabilities	152,041	83,853
Net. working capital	$673,647	$630,594

In reference to the new spring works of the company, the president said that it is expected to have the factory in operation at Oshawa by January, 1920. The new works will be called the Central Spring Company.

Burnett & Crampton, Rigaud, Que., contemplate building a new foundry capable of turning out about 250 tons per month of castings and will shortly be calling for tenders for the building and equipment.

The equipment will consist of molding machines, which with all other equipment will be of the most up-to-date type and they figure on having one of the most modern founderies on the continent specializing in high grade machinery castings, cement mill and mining equipment together with a general casting business.

The General Motors of Canada, Ltd., have awarded to the Canadian Stewart Company of Toronto a contract for the erection of a factory at Oshawa, estimated to cost $1,000,000.

A company has been incorporated for the manu-

facture of flying machines and parts under the names of the Allied Aeroplanes Company of Brantford, Ont., with capital stock of $40,000.

The Doheny, Quinlan & Robertson, Ltd., of Montreal, is has been incorporated with a capital stock of $2,000,000, by Hugh Doheny, Hugh Quinlan, Angus W. Robertson et al., to build railways, power plants and to do general contracting.

Quinlan, Robertson & Janin, Ltd., of Montreal, is incorporated to do business as general contractors, quarrymen, miners, etc., and to acquire the Laurin & Litch Company with capital stock of $500,000.

A Canadian branch of the Car Fastener Company, of Boston, Mass., is to be commenced in Hamilton, Ont. It is announced that the Company has purchased a building site with the intention of erecting a factory at once.

The Maine and New Brunswick Electrical Power Co. have let the contracts for an additional unit at their development at Tinker Station, N. B. This will make the fourth unit. The Foundation Co., Montreal, will enlarge the dam and power house, and construct a tunnel and new steel penstock. The water wheel will be of 2400 h.p., 400 r.p.m., complete with Lombard governor, working under head of 72 feet, and will be supplied by the Canadian Ingersoll Rand Co., Ltd., Sherbrooke and Montreal. It will be directly connected to a 1500 kv.a generator, to be supplied by the Canadian General Electric Co.

The Electric Furnace Company, Alliance, Ohio, has just shipped to the Dayton Engineering Laboratories, Dayton, Ohio, an electric furnace for melting and refining aluminum in the Delco plant.

This furnace has a hearth capacity of 500 pounds and a melting rate of 200 pounds of aluminum per hour. It is equipped with a double charging door in the front and rear, and otherwise is similar to the standard Baily Electric Furnace of 105 K. W. electrical capacity, and 1500 pounds hearth capacity, that is used for melting brass.

The growing tendency of employers to share profits with their employees or to give them an opportunity to buy shares in the business is illustrated by the incorporation of Beals, McCarthy & Rogers, the oldest continuous partnership in Buffalo, which has perfected arrangements to allow the department heads and principal employees to acquire an interest in the company.

The incorporation papers fix the capital at $1,000,000 and give the corporate name as Beals, McCarthy & Rogers, Inc., the title assumed two years ago when the name was changed from Beals & Co., as it had been known for 26 years.

The firm was organized in 1826, when Buffalo was a mere village, by Samuel F. Pratt and Edward P. Beals, under the name of Pratt & Co. It occupied incommodious quarters at 220 Main Street. From that beginning the firm's growth has kept pace with the progress of the city and nation. Now it is one of the largest iron, steel and hardware supply houses in the country. It does business not only in Buffalo, but throughout New York and several States of the Union, and Provinces of Canada.

"We have the proposition to enable our employes to acquire an interest in the business under consideration for a long time," Eugene J. McCarthy, president, said to-day. "It is only now that we have been able to realize the hope. We believe that it is a practical way to get results. We believe this step will make it possible for us to give better service, if that be possible, which will result from the fact that more persons will be working for a concern in which they have a definite financial interest aside from the salaries paid them."

SHIPPING NOTES

The third of the twenty French ships being built in Victoria, B. C. by the Foundation Company of British Columbia on her trial trip averaged over twelve knots speed, against a contract speed of eleven knots. The engines in this vessel, Hull No. 209, were furnished by the Vulcan Iron Works of Denver. The next ship to make her trials will be Hull No. 219, which will be equipped with the first set of engines to be made by Hutchinson Bros., of Victoria. No 219 is expected to go through her trials about the beginning of August.

Work on the New Welland Canal was suspended in January, 1917, on account of the war. At the beginning of 1918 the contracts were cancelled. In January, 1919, new contracts were made with the former contractors to resume the construction on the basis of cost plus 8 per cent. These contracts are to continue until the end of 1919, after which time the Department of Railways and Canals has the power to readvertise and award new contracts.

Work on the cost plus 8 per cent contracts which expire with 1919 is now in progress on sections 1, 2, 3, and 5, about 1,700 men working on these sections.

The following are the contractors on the different sections: No. 1, the Dominion Dredging Co.; No. 2, Baldry, Yerburgh & Hutchison; No. 3, Dohney, Quinlin & Robertson; No. 5, Canadian Dredging Co., all of St. Catherines, Ontario.

A steel cargo freighter, canal size, designed for trans-Atlantic service and built by the Dominion Shipbuilding Co., Toronto, Ont., was launched on July 12, and chistened Hessa by Mrs. J. Baird Simpson, of New York City. The Hessa is 261 feet over all, 43 feet 6 inches broad, and 24 feet 2 inches in depth, with a carrying capacity of 3,550 gross tons. She makes the seven vessel launched from the Dominion Shipbuilding Company's yards in the past nine months, and there are five more to come.

The steady inflation of values of second-hand steamers goes on without check, according to the Liverpool Journal of Commerce, Bristol Channel buyers continuing to give unstinted support to the market, and brisk demand is maintained, whilst sellers are as reserved as ever, assisted as they are by the considerably higher prices now being made for "standard" vessels. A very effective instance is afforded in the re-sale of the steamship Trojan to the Green Star Shipping Co., Cardiff, for the sum of $750,000, her late owner, E. C. Thin, of Liverpool, selling her to Cardiff buyers so recently as the middle of May last for the sum of $580,000, so that her latest purchasers have paid almost 30 per cent increase on the price paid less than two months ago. Cardiff buyers have also taken the single-decker Keyingham, of Sunderland, for $725,000, to be delivered at Liverpool, where she recently arrived with a cargo of sugar from Batavia. She is 6,130 tons d. w., and was built in 1908.

Purchase by the Canadian Robert Dollar Company of the British steamship War Melody, 1,800 tons deadweight, built by Harland & Wolff, Belfast, has been announced. Ultimately the vessel, now on voyage from Portland, Me., for England, will be placed in the Pacific service, out of Vancouver.

The Standard Oil Co., has sold the sailing ships John Ena and Dunsyre to the Robert Dollar Co. The price was about $250,000 a piece, or just about what the Standard paid for them in December, 1916, when they were bought from the Rolph Navigation & Coal Co. There has been considerable speculation as to why the Robert Dollar Company purchased these vessels, as they long ago discarded the use of sailing craft, and it is believed that they have figured on getting barley charters to Europe and then selling the vessel on arrival at a European port to Scandinavian purchasers, who seem to be very keen to acquire almost any kind of vessel. The figures now being obtained for transporting barley to Europe net a sum which would make it quite practicable to sell the vessels over there at less than they cost here.

One hundred steamships built on the Great Lakes during the war have been sold by the Shipping Board to the Anderson Overseas Corporation, of New York, for approximately $80,000,000. This is probably the largest ship sale on record, the Board said in announcing the deal to-night, and the vessels will eventually pass into French and Italian ownership.

Delivery of the ships will commence August 10 and proceed at the rate of six or more a week until completed.

DOMINION SHIPBUILDING COMPANY

The Dominion Shipbuilding Company, Limited, situated on reclaimed land owned by the Toronto Harbor Commissioners, and extending from Bathurst street on the west to Spadina avenue, on the east, with five building berths for canal-size ships, will consist of four buildings, when completed, with an approximate cost of $2,500,000.

The first building consists of the main building which takes in furnaces, bending slabs, angle iron, smith shop, punch shop with machinery for about 75-ton ship steel per day of nine hours, power plant, warehouse, joiners' and carpenters' shops and mould loft second storey. This building is 485 feet long, 210 feet wide in way of punch shop, 110 feet in way of power house, warehouse and joiners' and carpenters' shop. This building is complete and is made up of steel with re-inforced concrete walls, corrugated iron roof in way of punch shop and built-up roofing in way of mould loft.

The next building, now completed, will take in electrical shop, pipe shop, blacksmith shop and machine shop and pattern shop. This is 275 feet long, another 150 feet to be added on, by 110 feet wide, and is built of same construction as punch shop.

Electrical-Driven Machinery

The other two buildings will be foundry and boiler-shop and will erected as soon as conditions permit. There are three overhead cranes to take care of erection of steel for the ships. All machinery is electrical-driven, alternating current obtained from the Hydro system. There is also one set of shears legs of 100-ton capacity now erected, to take care of installing engines and boilers into ships immediately after launching. Foundations for building berths and shops are made up of piling driven down to rock bottom and concrete pillars on same.

It is estimated that the capacity of this plant, when complete, will be about twelve ships per year for canal size, 261 feet overall, by 43 feet, 6 inches beam, D. W., carrying capacity up to 4300 gross tons. The 1918 programme consisted of eight bulk freighters, two of which were delivered last Fall, two this Spring and the remaining four, now well under way, will be completed and delivered before the close of navigation. Four additional contracts are now under way for delivery next Spring. In laying out this plant, every precaution has been taken to avoid handling of material as much as possible and to make everything up-to-date and complete in every way with the above capacity in view, so that one department will not have to wait on another, but that work will be progressing through the different shops so as to avoid delay. The yard, as at present constituted, is entirely self-contained as a complete and up-to-date ship building plant with the exception of the boiler shop and foundry and these additions are contemplated in the near future.

COAL AND IRON IN INDIA.

The Report of a Commission appointed in 1916 by the Government of India under the presidency of Sir T. H. Holland, has been issued, and we excerpt from the editorial pages of the "Colliery Guardian" a summarised account of the extent of the coal and steel industries, which is comparatively unknown outside the circles immediately interested.

One interesting feature of Indian industrial life is the relatively large number of men employed for a given output of coal or steel. The capacity of the Tata Works is given as 17,000 tons of steel monthly, with the employment of 40,000 men. The Dominion Steel Company at Sydney produces approximately 30,000 tons of steel monthly, with a force not exceeding 5,000 men. The Indian laborer is physically frail, and not capable of the sustained manual exertion of the European in work calling for physical strength.

The "Colliery Guardian's" summary is as follows:

It is not possible, in these columns, to cover any considerable portion of the ground dealt with in this report, but it is worth while to consider briefly the position of India with respect to coal and iron, upon which almost every other branch of industry ultimately depends. Of the Bengal coal fields much has been written, and it is enough now to state that this report adds but little to previous knowledge, and throws but little light upon the influence of the war upon the output and distribution of Indian coal. In 1916, however, the following census of coal consumption was for the first time established:—

	Per cent.		Per cent.
Railways	33.6	Used at collieries	12.6
Bunkers	16.7	Small industries and domestic consumption	17.3
Jute mills	5.6		
Cotton mills	5.5		
Iron, etc., foundries	5.1		
Inland steamers	3.6		100.0

The Commission calls attention to the fact that the proportion of the coal output consumed by railways has been practically stationary for a number of years. We learn also that in 1917 the Bengal coalfield was worked by 153 joint stock companies, with a paid-up capital of Rs. 672 lakhs, besides many privately-owned mines. Although the best coal seams rarely contain less than 12 per cent. of ash, they furnish a strong coke capable of being used in the blast furnace, but the visible supply of this commodity is strictly

limited, and if the metallurgical industries are further developed the problem of an adequate output of coke will become urgent. The Commission recommends an early consideration of this question and advocates a special survey of the Indian coal situation, including the prospective development of the coal fields of Assam, where good coking coal exists. It is satisfactory, also, to note that a striking feature of the Bengal coal field is the technical development of the better-class mines. With comparatively low grade fuel and a limited supply of good coking coal, the prospect of organizing a native iron and steel industry of any magnitude would scarcely seem feasible; yet striking results have been achieved. The Bengal Iron and Steel Company at Kulti and the Tata Iron and Steel Company at Sakchi are the most important metallurgical enterprises yet attempted in India. The former company, handicapped at first by the use of low grade iron ores, has now greatly improved its position. The company operates four blast furnaces, producing about 10,000 tons of pig iron per month, and since November, 1917, has turned out between 1,200 and 1,500 tons per month of ferro-manganese, which has been exported to Europe and America for war purposes. A large foundry is also operated for the manufacture of pipes, railway chairs, and other castings. The Tata Company, formed in 1907, only commenced active operations shortly before the war, and has already grown to considerable dimensions. It owns nine large coal mines and possesses iron mines of importance at Gurumasini and elsewhere. Two large blast furnaces, each making about 350 tons of iron a day, are in operation, and three more are in construction. Coke is supplied by 180 non-recovery Koppers coke ovens, but a new plant, consisting of 20 13-ton by-product recovery ovens, with a benzol plant, is being installed. The steel-making plant includes four basic open-hearth furnaces of 50 tons capacity, and two of 75 tons capacity, with another in process of construction, while further extensions, consisting of two 25-ton Bessemer converters, three electric furnaces, two 200-ton tilting furnaces, and a 1,300-ton mixer, are now under way. The present steel capacity is 17,000 tons per month, and the rolling mills produce 120,000 tons of rails and other sections yearly. This company is still in the development stage, and large additions to the plant are under contemplation. The works already employ nearly 40,000 men, and a large town is springing up at Sakchi for their accommodation.

The progress made in iron and steel production within the last decade has been highly encouraging, and appears to have already falsified the opinion previously held in India as to the possibility of organising a large metallurgical industry on modern lines. The future, however, seems to be mainly involved, as indicated above, in the problem of the supply of blast furnace coke.

It does not seem to be quite clear from this report whether the Commission really believes that India can become so great a producing country as to be capable of doing without imported machinery. Undoubtedly this was the end in view, for attention is called to the great danger to which the Indian textile industries would be exposed if Britain's command of the sea were lost. The question, therefore, is not only the establishment of a metallurgical industry, but the development of engineering workshops in which the output of steel can be absorbed.

EDITORIAL

BY-PRODUCT COKE OVENS IN CANADA.

During the war-period notable additions have been made to the by-product coke-oven installations in Canada, all of these, with the exception of the Granby Consolidated Smelting & Mining Company's ovens at Anyox, B.C., being part of a programme of extension in the iron and steel manufacturies of the country. The production of coke in bee-hive ovens is quite properly becoming an obsolete practice, although there are still to be found persons sincere in their belief that by-product recovery "takes the strength out of the coke," whatever that may mean.

In the United States an even more remarkable reversal has taken place, and during this year, for the first time, the tonnage of by-product coke has exceeded that made in the beehive-oven plants in the States.

The question of the disposal of the by-products, and their further refinement, is therefore of much interest to the steel industry in Canada, and, in addition to a paper on benzol fuel for motor engines which is contained in this issue, there will also be found some extracts from a comprehensive treatise on the relation of the coal resources of Canada to our industrial development, by Mr. F. E. Lucas, the Economy Engineer of the Dominion Steel Corporation, which is contained in an appendix to the Final Report of the Fuel Controller. Mr. Lucas' paper has not attracted the attention it deserves, chiefly owing to the fact it appeared in a government publication and not in a technical journal. The work of civil servants is too often disregarded when it is reported in report form, notwithstanding the lavish distribution of government publications without cost to the reader. It is one of the contradictions of human nature that things easily come by are lightly regarded.

The Final Report of the Fuel Controller is a striking example of this curious fact, and while a few specialists have recognized the value of Mr. Magrath's work, and of his final testament as Fuel Controller, this Report, which is the most authentic and complete monograph on Canada's fuel problem yet attempted, received practically no notice in the newspapers, and scanty reference in the technical press of Canada.

Mr. Lucas, in his paper, showed that by turning coal into coke and recovering the by-products in the process, there could be obtained from 2,000 tons of coal costing $4.50 per ton, by-products to the value of $15,-250. In the light of this consideration, which, by the way, is neither new nor striking to those who have studied fuel problems, it is not surprising to know that it was recently stated in Britain by one of the best-informed fuel engineers of today, that the use of coal in the raw state for domestic heating, for power-raising, and other purposes for which raw coal is now generally used, will before long be prohibited as a wasteful, dirty and generally inefficient procedure.

MANUFACTURERS' GUARANTEE IN COAL WASHERIES.

In this issue is a paper by Mr. Sherwood Hunter of the Simon-Carves Coke Oven Construction Company read before the Midland Institute on "Some Suggestions for the Standardising of Guarantees for Coal Washeries," which is a plea for a uniform standard of efficiency in coal washing and a clearer understanding as to the meaning of the usual guarantees concerning the percentages of "coal" and "dirt."

The actual performance of coal washeries compared with the guarantees contained in the contract with the manufacturer has proved a fruitful source of dispute and of litigation, largely originating in the failure of specify the exact interpretation of what is "coal" and what is "dirt." As Mr. Hunter points out, the most practicable manner, although it may not be the best or final manner, to define these vague terms is to specify in terms of the float test the sinkings that are properly classified as "dirt," and the floatings constituting the "coal."

In the discussion upon the paper one of the speakers expressed the opinion that washery contractors had in the past had things very much their own way, and that some of the guarantees were not worth the paper they were written on. There is some truth in these statements, because it is only recently that mining engineers have seriously interested themselves in the technicalities of coal washing, and, in default of more precise technical knowledge, the form of guarantee has been largely left to the constructors of coal washeries themselves.

Mr. Hunter is the technical representative of a well-known firm of washery contractors, and has been concerned with a number of washeries erected in Canada and the United States, where no doubt some of the difficulties experienced in connection with guarantees occurred.

In a washery where one grade of coal, or coal from one seam or colliery is to be treated, there is no difficulty in determining and drafting the terms of a precise and satisfactory guarantee, if sufficient pains are taken to ascertain the physical peculiarities of the coal to be treated, but in a case where a number of coals, from different seams, having different specific gravi-

ties and different physical composition, and arriving at the washery for treatment in differing quantity percentages, no very satisfactory guarantee is possible, because the factors are indeterminate.

Mr. Hunter's paper is useful in that it calls attention to the necessity for care in drafting the terms of the performance guarantees in the contract for a coal washery, and for a thorough understanding and prior agreement on the definition of the terms used in the document, particularly to avoid the use of such loose expressions as "coal" and "dirt."

No mention is contained in the paper as to the guarantees of the percentage of sulphur and moisture in the washed product, which are more important objects of coal-washing to the steel maker than the removal of ash content, except of course as the sulphur may be concentrated, as it often is, in the interlaminated earthy matter, the limey flakes, and the "brass" which combine to make the undesirable matter in coal removed by the process of washing, and commonly known as "dirt." The percentage of moisture and sulphur present in the washed coal is naturally determinable with accuracy, and is not open to ambiguity, but, nevertheless, equal care is required in framing the contract, and in the investigations preliminary to the agreement upon the moisture and sulphur percentages.

Complete frankness with the washery manufacturer is desirable if the best results are to be obtained, and all the relevant data should be freely disclosed to him by the colliery operator. The purpose for which the washery is to be operated should be thoroughly understood, as the design of a washery to treat coal intended for use in steam-raising, will be radically different to a washery designed to fit coal for the manufacture of coke for steel-making purposes.

In the past it has been said that certain coals were non-metallurgical, much as certain iron-ores are said to be unsuitable or unkindly. The question of quality is in the first degree relative. Poor and brassy coals can be made suitable for metallurgical purposes by scientific washing, as certain ores can be beneficiated and used with success, where higher grade ores are not available.

The preparation of coal for metallurgical uses by washing is daily becoming a matter of greater importance to coal and steel operators in Canada and in the United States.

BENZOL AS A MOTOR FUEL.

"Iron & Steel" is pleased to be able to include in the present issue a very practical paper by Mr. I. C. Mackie, the Metallurgist of the Dominion Steel Corporation, which records a series of trials demonstrating the suitability of benzol and benzol mixtures as a motor fuel. Mr. Mackie's paper was prepared for a meeting of the Maritime Chemists' Association recently held in Sydney, N.S., and while he would be the last to claim for his investigations anything really and importantly novel, yet it is by just such actual and practical experiment that new products, or by-products, must be locally tested and introduced before they claim a wider attention and market.

The marketing of the light oils recovered from coke oven distillation of coal is a matter that very much interests the steel companies in Canada, most, if not all of whom, have extensive coke-oven plants with by-product recovery. The market for motor fuel is one that is daily increasing and one that has before it indefinite possibilities of expansion. Mr. Mackie's short paper will therefore attract attention as a concrete demonstration of the excellent characteristics of benzol motor fuel.

THE CANADIAN INSTITUTE OF MINING AND METALLURGY.

By the desire of its membership expressed through a letter ballot, the Canadian Mining Institute will change its name to the "Canadian Institute of Mining and Metallurgy," or such modification of this dual title as the Council may determine.

The C. M. I. "Bulletin" for August points out that a majority of the members of the Institute are miners, and that by their vote favoring the change of name, they have paid a graceful compliment to their fellows of the allied profession of metallurgy, and at the same time "have fittingly expressed their recognition of the important position now occupied by the metallurgical industries of Canada."

This is very nicely put. It is perhaps not fully realized how important the metallurgical industries of Canada are. The entire mineral production of Canada, as given in the Preliminary Report of the Department of Mines, for 1918, is valued at $210,000,000. The value of the steel ingots and castings, of ferro-alloys, and of coke and coal by-products produced directly in connection with steel manufacture is well over $100,000,000, or approximately equal to one-half of the entire product of the mines.

The capital expended in the plants designed to produce gold, silver, nickel, copper, zinc, lead and other metals from their ores is invested largely in the reduction plants and refineries, and, to the coal and ironstone miner at least, nothing is so striking about the precious-metal mines of Canada as the comparatively small plant required in the mine itself compared with the enormous installations of the surface.

A recent number of the Canadian Chemical Journal devoted to the Shawinigan industries is a revelation of the tremendous growth of the metallurgical industries in Canada, particularly in regard to aluminum, ferro-alloys, magnesium and the manufacture of electrodes. The export of aluminum from Canada, for example, has increased from a value of $1,760,000 in 1913 to a value of $7,620,000 in 1917.

In regard to many of the complex ores found in Canada, mining only becomes an economic possibility when

the metallurgist has shown the way to treat the ore, and the development of such natural alloys as "Stellite" and monel metal is altogether the work of the metallurgist.

It has been argued that "mining" is a comprehensive term, capable of including all the outgrowths or ramifications of the product of the mines, but surely such a science as metallography, and all the later developments of heat treatment cannot be included in the scope of the term "mining"? And, further, it is certain that the Canadian Mining Institute desires to hold the metallurgists already within its membership, and to widen its boundaries as knowledge widens.

Therefore, it seems evident that not only has the Canadian Mining Institute done a graceful thing in welcoming the metallurgist specifically and by name, but it has done a thing wise and judicious, evidencing in its members prescience and courtesy as felicitously combined as the two great designations of the miner and the metallurgist are combined in its new title.

THE GENERAL STEEL OUTLOOK IN CANADA.

The steel industry in Canada is passing through a waiting period, and the companies are utilizing the lull to make extensive repairs of plants that were worked at high pressure during the war period.

In Nova Scotia all the blast furnaces are closed down. The Dominion Company has re-lined two blast furnaces and now has six furnaces in first-class condition for production. The Nova Scotia Company is relining the furnace that has been in use for a period exceeding five years and has another completely new furnace ready for operation.

The new plate mill at Sydney may roll plates late in the year or early in 1920. The wire-rod mill is working single shift and the wire and nail mills are working on export business.

The Scotia plant at New Glasgow and the Car Works there are working about 75 per cent capacity.

In Ontario the steel plants are operating at not more than half capacity, and one of the most interesting announcements of recent date is that the Algoma Steel Corporation, commencing about 1st November, will be ready to produce and ship American standard sections of beams and channels, angles, zee bars, rounds and squares and flat-bars, and the further intimation by the President that attention is to be shortly devoted to the erection of a structural mill. In this issue of "Iron and Steel" will be found some references to progress in the manufacture and standardization of structural steel in Britain, which show that British manufacturers have realized the impending change in construction materials and the greater importance that structural steel is going to assume from now on in the building trades.

Canada is a young country with a prospect of increase in wealth and population at least equal to that which has taken place in the United States since the Civil War. Not every Canadian, indeed only a select few, have glimpsed the transcendent importance that Canada will assume within the next fifty years. At the present time we are about to experience the reaction of a five years cessation of building construction, coming on top of a period when Canada was beginning to plan for increase of her inadequate housing accommodation and her equally inadequate business buildings. A casual walk down St. Catherine's street in Montreal will reveal some of the possibilities of the future in building construction. Here is a street that is a strange commingling of the new and the old, of modern structures completely utilized and none too large for the business they house, side by side with buildings of a former and smaller time, clearly waiting for the site to be cleared and buildings to arise that shall be commensurate with the coming importance of the main business thoroughfare in the business metropolis of Canada. The Algoma Corporation is to be congratulated on its vision in commencing the manufacture of structural steel and small commercial sections.

One fault of the larger steel companies of Canada has been their reliance on one main product, necessitating large tonnage production for profitable operation, and somewhat out of balance with the requirements of Canada itself.

Under Canadian conditions it is not clear that large specialized plants, making one main tonnage product, are quite fitted to our national needs, although they may be fitted for large export business. The form of organization that seems most likely to succeed is the one that owns coal and ore deposits, and that in addition to manufacturing steel, will carry the manufacture of finished steel products to a wider extent than has yet been attempted. "From the ore to the finished product" is the expression of a thoroughly practical idea. The finished product should include the complete fabrication of ships, and it should not stop short of such finer manufactured products as cutlery and small general hardware. It is not suggested that the larger steel companies should undertake the manufacture of these later stages of steel and iron fabrication, but the idea before the trade should contemplate the manufacture of steel in such grade and of such size and shape as will foster the evolution of the numberless small trades that should grow out of a basic iron and steel industry.

Tonnage, and still more tonnage, has been the leading idea of United States steel manufacture, and in that country illimitable coal resources and most important iron-ore deposits, the idea properly consorted with the genius of the United States citizen.

The question is whether in Canada we are properly guided in endeavoring to transplant the tonnage idea to our own soil, or whether Canada should not accept some of the limitations of her national resources, and

to some extent abandon the idea of tonnage quantity and substitute specialization of product and good quality.

The magnificent water powers of Canada lend themselves to the development of an electric smelting industry. Canada is a veritable storehouse of rare alloys, and metallurgy is a peculiarly Canadian specialty.

We lack — compared with the United States — the generous and equable distribution of coal and bessemer ores that our neighbors are blessed with, but we have every essential for the manufacture of alloys, fine steels, cutlery, machine tools, and such industries as Sweden and Switzerland have specialized in.

Export business is another consideration, and some of our steel enterprises are finely situated for export, but until Canada is able to supply a much greater part of her steel imports than is the case to-day, export business is really a secondary consideration, from a strictly national viewpoint.

Meantime, the confidence of the people of Canada in the basic soundness of the steel industry of the country is evinced by a number of new incorporations and company developments. Among these may be noted the intention of the Lake Huron Steel Company to erect a modern plant, including electric furnaces, at Goderich, the acquirement of the British Forgings Plant by Baldwin's Limited, of Swansea, Wales; the incorporation of the Consolidated Iron & Steel Corporation of Toronto, with the announced intention of developing iron deposits in the Michipicoten District and near Brockville; the incorporation of the British Foundation Ovens, the new plant of the Canadian John Wood Company at Toronto, and the extensions of the existing steel companies already briefly referred to.

As "Iron and Steel" has previously pointed out there is good ground for reasoned optimism in connection with the future of the steel industry in Canada, notwithstanding the present lull and the rather uncertain outlook for the autumn.

RECENT DEVELOPMENTS IN JAPANESE TRADE.

Some remarkable information regarding the commercial rise of Japan during the war period was given by Mr. E. F. Crowe, Commercial Counsellor to the British Embassy in Japan in a recent address before the London Chamber of Commerce.

Japan, it appears, emerges from the war with a reduction in her national debt, a unique position among the belligerents.

It is to be hoped that the Japanese will not interpret history as did the Pan-Germans before the war, for their experience of wars is similar to Prussian experience before they invited Britain to a fight. Mr. Crowe said: "Since Japan emerged from her seclusion she has "been at war three times, and each time has come out "stronger and more powerful. In a period of 25 years, "during which she fought three successful wars, her "trade has increased more than 2,000 per cent."

In 1913 Japan's exports were of the value of £64,500,000. In 1918 they had grown to £215,000,000, an increase of 230 per cent. Among new exports which have developed during the war are noted £700,000 for wire ropes, £800,000 for copper sheets and wires, and £900,000 for insulated electric wire. Japan now exports such materials as acetic acid and calcium carbide, these two items running £400,000 each annually. In window glass Japan has changed from a large importer to an exporter of glass to the value of £350,000 in 1918. Rubber goods, before the war an import item into Japan, are now exported to the value of £460,000, and in 1918 Japan imported for manufacturing purposes crude rubber costing £1,400,000. Among the miscellaneous new exports are glass bottles, and beads—including bracelets for India—thermos flasks, watch crystals, sewing needles, cutlery, cycle parts, electric fittings and lamps, and, strangest of all, Japan's export of beer has increased from £80,000 worth to £800,000 annually. The market for this beer is chiefly India, Java and the Straits.

As bearing on competition with Canada, and other parts of the Empire, it is significant to notice that the hours of labour in Japan average 70 hours a week, and that there is no half holiday on Saturday or any holiday on Sunday. The Factory Act calls for only two holidays a month.

With regard to that most important necessity of a manufacturing country, coal, Japan has her own coalfields, but during the war the cost of mining and transportation has enormously increased. Industrial coal, which before the war cost from $3.00 to $3.60 per ton delivered near Tokio, now costs $12.00 and just prior to the Armistice cost $18.00 per ton. The consumption of coal in Japanese factories is close on 12,000,000 tons annually, or approaching the entire quantity of the coal production of Canada.

In conclusion Mr. Crowe said:

"I hope I have made it clear that the danger from Japanese competition is not serious, provided that we get back soon to normal conditions, and that our output "is not unreasonably curtailed and profiteering allow-"ed to go unchecked. The fact that Japanese industry "is in a state of transition from the cottage to the fac-"tory, must, for some time to come, affect the quality "of her goods. Her labour, though cheap, is not very "efficient. Even its apparent cheapness may not per-"haps continue for long, as the cost of living is rising "and wages must necessarily advance. There is com-"paratively little research work being done, and many "of the industries have not emerged from the initiative "stage. Japan has practically no iron mines, and she "is dependent on foreign sources for nearly all the im-"portant raw materials she requires, with the excep-"tion of silk and copper. Moreover means of com-"munication are somewhat defective, and seriously "hamper the development of trade and industry on a "large scale."

There is much food for thought in this first-hand information from a trained observer. Japan appears to be passing through that phase of industrialism through which Great Britain passed in the first half of the nineteenth century, in those deceptive times of the Early-Victorian Age which Jan Smuts has recently blamed, and rightly blamed, for many of the evils of today. The transition of industry from the cottage to the factory is a period fraught with much social danger, particularly where the working population is so poor, so ill-informed and docile as the workers of Japan. Mr. Crowe remarks that the Japanese rely on officialdom for assistance to a degree that would be quite inconceivable in Britain. It is to be hoped that factory conditions and industrial housing will not bring in their train the impairment of bodily physique that resulted from the factory system in Britain, and rendered it necessary to recruit "bantam regiments" in Lancashire and other centres of factory activity.

Mr. Crowe points out that while trades unionism does not exist in Japan, and that strikes have been few and unsuccessful for the workers, but significantly adds: "The most frequent and successful strikers in Japan are the "schoolboys, and the schoolboy of today is the man of tomorrow."

There appears to be an opening in Japan for up-to-date machinery and machine tools. The machinery which Japan has been able to purchase from outside during the past few years is antiquated and bought at "terrific prices." Japanese firms themselves are making headway in the manufacture of machinery, but at the present time this industry is in the formative stage, and offers an opportunity for Canadian exporters of mine and mill machinery, electrical machinery, machine tools, and chemical and metallurgical equipment.

From a business point of view, Japan is worth cultivating and the taking of pains to understand. With Canada in particular, by reason of geographical position, trade relations must always be intimate, and should be mutually profitable.

From the standpoint of world-politics, as understood by our own people, in contradistinction to the Teutonic misuse of that term, Japan presents a careful problem. The striking social rise of the "trader," the apparently profitable pursuit of military power, the difference between East and West in ethical conceptions, the brilliance of the trained Japanese intellect, the danger of selfish exploitation of the working classes and the advantage this gives in competition with nations that have differing conceptions of the social order, make it desirable that we should at least acquaint ourselves with facts regarding Japan, and thereby avoid misunderstanding and retain the friendliness and mutual respect which now exists. We remember that during the recent war Japan kept faith with us and rendered efficacious aid, particularly in protecting the Pacific coast of Canada from naval attack by Germany.

OCCASIONAL NOTES.

With regard to the origin and limiting of transverse fissures in steel rails, Mr. Paul Kreuzpointer in "Iron Age" says the unequal distribution of the metalloids in the steel, especially the phosphorus, and the condition in which the phosphorous is found, are the primary causes of the formation of fissures, and that by re-heating or prolonged heating of the steel which would occasion a more uniform diffusion of the metalloids through the steel, breakage of rails due to internal fissures could be lessened in number.

The deteriorating factors are: Slag inclosures; nests of phosphorus in varying combinations; disproportionate diffusion of the metalloids at a given degree of heat, the ratio of diffusion of phosphorus to carbon for instance being seven to one, that is, phosphorus diffuses seven times slower than carbon; increase of destructiveness by irregularities in the rail head owing to larger grain size; unavoidable difference in grain size in different cross-sections of the rail resulting in impairment of rapidity of dispersion of vibratory motions and flow of metal produced by rolling load.

On analysis the conclusion suggests itself that the formation of internal fissures is the result of a combination of contributing factors, rather than of one factor and that the deteriorating influences of these injurious factors can be largely modified by judicious heat treatment.

Mr. Kreuzpointer believes that present day methods of mass production, and the demand for rapidity of production are largely responsible for the trouble, and that much could be done to obviate the many expensive troubles that arise from failure of steel rails and other varieties of rolled steel by raising the general standard of intelligence of the mill operatives.

Andrew Carnegie, in writing in his own handwriting and language those clauses in his will providing annuities for Lloyd George, Lord Morley, President Taft, and Mrs. Grover Cleveland and Mrs. Roosevelt, has written his own best epitaph.

The man, who was large-minded enough to select these tribunes of the people and of liberty as the objects of his munificence must have been no common person. That he was able to do it is a mere accident of his wealth. That he should have conceived the idea is the main thing, for not only is the conception somewhat new, but it is very daring, and indicates the sense of responsibility Mr. Carnegie possessed with regard to his great riches.

There is reason to believe that the representatives of Canada who were sufficiently presumptuous to request the King not to confer further titular honours on the large remaining number of Canadian citizens not consulted by our legislators in framing the resolution, were influenced not so much by a dislike to titles, but by

disgust at the manner in which titles have been granted. The persons selected for titles, as persons whom the King delighted to honour, have not always been distinguished by such eminence above their fellows as to make the reason for the honour conferred entirely apparent, or it may be said, in some instances, the reasons have been only too apparent.

The recent formal opening of the Quebec Bridge by the Prince of Wales is a reminder that not a single honour has been conferred on the engineers who constructed this unique Canadian achievement.

We believe the engineers who, after many tribulations, achieved this modern marvel—for it is not less than that—would be the last to ask titular honours, but the patent omission, and the extraordinary, but by no means self-denying ordinance of our legislators referred to, indicate the necessity for some means of honouring those men amongst us who contribute notably to the advancement of the race.

Engineers and scientists seek more avidly the select professional honours conferred by appreciative and discerning fellows in learned societies, but are there not citizens of Canada worthy of such public commendation as is conferred by the King, when as the representative of the nation, he grants a title of eminence? Are not many of these men just as entitled to honour as successful stockbrokers and wealthy brewers?

RUIN AND RESTITUTION IN FRANCE.

By the courtesy of the Editor of "Mining & Scientific Press" of San Francisco, we are enabled to reproduce in this issue of "Iron & Steel of Canada," a series of photographs which show so clearly as to render comment superfluous the thorough manner in which the Germans destroyed the basic coal and iron industries of Northern France.

The photographs were personally taken by Dr. Frank H. Probert who visited France as a member of the United States Mining Mission, with Dr. F. G. Cottrell and Mr. George S. Rice of the U.S. Bureau of Mines, who were given the fullest facilities to see the systematic manner in which Germany attempted to compass the commercial ruin of France.

The destruction is not confined to bombardment havoc. The largest steel works in France, where not a shell was fired, were gutted, and left as Dr. Probert says—"a mass of fallen stone and twisted steel, a scrapheap impossible to describe."

The Pas de Calais and Nord coal mines have suffered worse than the steel plants. The surface plants of the collieries were deliberately destroyed by the retreating Germans as late as October 28th, 1918. The coal measures are overlain by water-bearing strata and quicksands, the shafts being sunk by special boring methods and lined with steel cuvellage. This was blasted by dynamite and the mines flooded. The surface plants which escaped did so because of lack of opportunity to destroy them.

Dr. Probert says: "Every building, every headframe bears a label giving the estimated quantity of high explosive necessary to wreck it." Near Lens, the little river of Souchez was turned into the mines, and for part of its course has disappeared, now flowing through the underground workings.

Truly scientific knowledge combined with savagery is a fearsome thing.

The Japanese are said to be exploiting on a large scale the ores discovered in Korea, and to be making extensions in their industries to handle this new source of supply. Ore concessions in China will further increase the Japanese raw material. A British correspondent predicts not only that Japan will soon be independent of outside sources of supply, but that in another ten years she will be exporting cheap steel to the Pacific markets, and even breaking into more distant markets like Great Britain.

CONDUCTING ALUMINUM—A NEW INVENTION.

(Consul Philip Holland, Basel, Switzerland).

A new invention called conducting aluminum M.277, which is said to be creating a profound impression, has been made by Dr. Georges Giulini, the most famous expert in the aluminum trade. This new metal is produced by putting the ordinary aluminum through a special patented process, by which it acquires the same mechanical qualities and capacities as bronze, copper and brass without changing its specific weight.

It is said that the price of the new metal can be kept within very low limits; so that, even at the pre-war prices of other metals, it will be able, by reason of its smaller specific weight, to compete with copper and brass very favorably. The fact that the new metal is a conductor will make it especially in demand in the electrical trade. The inventor anticipates for it also a good market among the builders of motor cars, aeroplanes, ships, and railway carriages. Leading men, to whom the invention is already known, are said to be much impressed with its possibilities.

MODESTY OF GREATNESS.

When little politicians and collegians are so ready to assume supervision of vast industries, no matter how efficiently they have been conducted in the past, it is refreshing to be impressed again with the modesty of greatness, as revealed in the following statement by John S. Miller, of Chicago, leading corporation lawyer in the West for a couple of generations:

"Most of us who have not been in industrial and commercial business are incapable without great study and preparation to sound it, to get the secret of its proper conduct. However honest we might be, we might blunder a good deal before we could fathom it, as those who have built it up could do."—Boston News Bureau.

With a capital stock of three million dollars the British Refractories, Limited, with head office at Montreal, has been granted incorporation to carry on business as manufacturers and dealers in bricks of all kinds, and among other things to acquire the rights for the British Empire in or to processes for the manufacture of silica bricks and refractory materials of all kinds.

Economic Possibilities of Coke-Oven Bye-Products in Canada

Extracted from a paper on "The Coal Resources of Canada.—Their Relation to the Industrial Development of the Country." ....

By F. E. Lucas.

Gas.

If the plant is near a large city or thickly populated district, it might all be sold for domestic lighting and heating. This is done in many districts by selling direct to existing gas companies, for no gas company can produce gas at the price at which a by-product coke plant can afford to sell it. Or if there are large industrial works within reach, it can be sold to them and at such a price as to be more economical than coal, or it can be used in gas engines, and power developed. The figure generally accepted as being reasonably conservative for gas-engine practice is 11,500 B.T.U. per horse-power, and it will be readily seen how tremendous quantities of power can be available from this source.

Gas supplies for domestic use must have the sulphur extracted. This is done by iron oxide, from which the sulphur can be recovered for the manufacture of sulphuric acid, which is needed for the production of ammonium sulphate.

Tar.

This product can be used directly as a boiler or furnace fuel by being burned in the same manner as oil, or it can very cheaply be dehydrated and the more highly volatile matter extracted and then used for road binding. Even for firing it would be found advantageous to dehydrate. Some tars, depending on the temperature and conditions of the coking process, can be used as fuel for Diesel engines. The most economical way to handle the tar, however, is to distill it and recover the various volatile fractions, such as the benzol, toluol, naphtha, the carbolic oils, creosote, naphthalene, and pitch.

The benzol, toluol, naphtha, etc., can be added to that recovered directly from the gas, for motor fuel. The crude carbolic finds a market with manufacturers of antiseptics, colours, explosives, and a great deal is used in recent years on the manufactures of phonographic records, imitation amber for pipes, etc.

So far as the value to the country is concerned, the creosote recovered is one of the most valuable by-products of the coal. Railway ties have doubled in price in the last ten years, and there is every prospect of a **pro rata** increase in further years. The forestry branch reports 19,100,000 ties used on Canadian roads in one year. A fairly safe assumption would be a complete renewal of all ties every five years, while fifteen years might be taken as a reasonable average life for creosoted ties. The cost of creosoting is less than the cost of a new tie, so that the creosoting of the ties becomes not only a commercially attractive proposition, but will save many millions of feet of lumber annually.

The same process of reasoning may be applied to mine ties and timbers, and also to bridge timbers.

The general adoption of the creosoting process would materially reduce this number in a few years. If we assume a consumption of only 10,000,000 ties per annum there would be required about 25,000,000 gallons of creosote oil per year, or the distillation of 85,000,000 gallons of tar, which would in turn require the carbonizing of 8,000,000 tons of coal.

The naphthalene finds a market as a colour base. For the manufacture of deodorizers, disinfectants, moth balls, etc., and also in the manufacture of a chlorinated wax for use in electrical work.

The pitch remaining can be made of almost any consistency desired. It can be made so hard that it can be pulverized and used as boiler fuel or in the same state it can be used as a binder for briquettes. In its softer state it is also used as a binder for briquettes, for roofing and road making. It is also mixed with the lighter portion of the distillate for the manufacture of paint for special purposes.

Ammonia.

While this has been shown in the balance sheet as sulphate of ammonia which is used almost entirely as a fertilizer, yet it can be recovered in the form of concentrated liquor containing from 16 to 25 per cent ammonia for the manufacture of explosives, or in the form of dry ammonia gas for refrigerator purposes, or as the aqua ammonia of commerce and chemistry. However, these are only small markets when compared with the market as a fertilizer. Its only competitor as a nitrogenous fertilizer is nitrate of soda from Chili, and as the population of the country increases and virgin lands become exhausted, we must, if we are to be fed, keep up the productiveness of the land in a great measure by the use of artificial fertilizers.

An investigation into the yield per acre of Great Britain and the amount of nitrogenous fertilizers used when compared with America will readily substantiate these statements and set at rest any doubt regarding future markets. Considering agricultural acreage of Canada and the fact that except for such parts as are growing leguminous crops the dressing for some crops should be even as high as 250 pounds of sulphate of ammonia per acre per year, we have further proof of the continuity of the market.

Benzol.

Under this name is often included the toluol, xylol and naphtha, which are recovered at the same time. Each of these products, together with naphthalene, can be recovered separately and refined to their chemically pure state, and there would undoubtedly be a market for a small quantity of each for solvents, dry cleaning, dyes, explosives, etc. During the war the toluol and a considerable portion of all benzol recovered was used in the manufacture of explosives.

The great market now the war is over is undoubtedly to combine the four products, benzol, toluol, xylol and solvent naphtha, as a motor fuel, giving a product which distills between 78 and 165 degrees C. This fuel has been carefully tested and found to give from 20 to 30 per cent. greater mileage than the best gasolene, with about 15 per cent. greater power, easier starting, no knock with advanced spark and actually less tendency for the formation of carbon in engine cylinders. Benzol itself comprises approximately 70

per cent of the fuel and this freezes at 14 degrees F. The addition of the toluol and other products named in the proportion in which they are recovered, brings the total fuel mixture down to a freezing point of approximately zero F., so that to make an all-year fuel for our climate we have to mix with sufficient gasolene to lower the freezing point still further. The addition of 25 to 30 per cent of gasolene gives a freezing point low enough for most places, except in the north, where it might be necessary to add as high as 50 per cent.

According to Government statistics, Canada's consumption of gasolene in 1916 was 74,000,000 gallons, of which 18,000,000 gallons was imported as distilled product, and most of the remainder was made from imported crude oils. So that it is evident that with a total Canadian production of say 20,000,000 tons of coal, if it was all cabonized and the motor fuel recovered, the market would still be far short of being satisfied. This does not take into consideration the fact of the continued yearly increase in consumption which is bound to occur.

In the low temperature distillation of coal as distinct from the ordinary coking practice the same products are recovered, but some of them in different proportions. The solid fuel is about the same. The ammonia the same or slightly less, but the tar is three or four times as much. It is, however, of a very different quality, containing much of the lighter hydrocarbons which in coking practice are afterward rerovered from the gas.

There are several patented fuels being made by this process such as coalite, carbo-coal, etc., and the process has long passed the experimental stage It will undoubtedly be found economically sound and commercially attractive to use this process in some districts.

Production Cost.

This means a saving of at least 10 per cent. of the coal actually put in the ovens, as well as the recovery of the by-products. I give herewith a comparison between bee-hive and by-products ovens, from tests actually made on Nova Scotia coal:—

Comparisons Beehive and By-Product Coke.

Beehive—

- Ordinary type 12.5 feet in diameter.
- Produces 4 net tons coke in 48 hours or 2 net tons per day of 24 hours.
- Yield of coke from coal, 60 per cent.
- By-products and surplus gas, none.

By-Product Oven—

- Oven charge, 11 net tons.
- Coking time, 16 hours.
- Coke produced; 71 per cent. yield; 7.8 net tons per oven; 11.7 tons per day of 24 hours.

By-Products—

- **Ammonium sulphate.**—27 pounds per ton, equal to 38 pounds per net ton coke; value 2.5 cents per pound above cost of manufacture; equal to 95 cents per ton of coke.
- **Tar.**—9 gallons per ton of coal; 12.7 gallons per ton of coke; value 2.5 cents per gallon, equal to 31¾ cents per ton of coke.
- **Surplus gas.**—6,000 cubic feet per ton coal; equal to 8,450 cubic feet per ton of coke, at 25 cents per 1,000 cubic feet; equal $2.11 per ton of coke.
- **Motor fuel.**—2¼ gallons per ton of coal; equal to 3.17 gallons per ton of coke; value 30 cents per gallon; equal to 95 cents per ton of coke.

Total value of By-Products as above—

Ammonium sulphate	$ 0 95
Tar	0 31
Gas	2 11
Benzol products	0 95
Per ton of coke	$ 4 31

Add to the above the difference between 60 per cent yield in beehive ovens and 71 per cent in by-product ovens on the same coal, taking coal at $2 at the ovens.

Coal per ton of coke in beehive oven	$ 3 32
Coal per ton of coke in by-product oven	2 80
Balance in favour of by-product oven	0 52
Total saving per ton, $4.31 plus 52 cents	$ 4 83

Resulting in $56.51 per oven in 24 hours, or $20,626.15 per oven per year, which amount according to pre-war prices would pay for the building of the by-product oven.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS.

Chicago Meeting.

In view of the large number of coal mines centered about Chicago, it is planned to make the Chicago meeting, to be held at the Congress Hotel, September 22-26th, of especial interest to the coal industry. A large proportion of the 150 technical papers prepared for discussion will be on subjects related to coal, coal mining and coke. Among these is a carefully prepared symposium on sulphur in coal. Excursions have been arranged during the meeting that will be particularly attractive to the coal man; on Thursday the trip to LaSalle will include the inspection of operating coal mines in the district, and late Thursday night a party will leave for the mines in Franklin and McCoupin Counties, where some novel and ingenious ideas in plant design and methods of operation have been adopted and proven practicable. The trip to the Gary Steel Mills on Tuesday will include an inspection of the immense coke ovens and by-product plant.

Metallurgists and electrical engineers will be much interested in the demonstration to be made of the production of metallic tungsten and molybdenum at the plant of the Fansteel Products Company, North Chicago, on Tuesday, September 26th. As a part of the programme for the Chicago meeting, an excursion has been arranged to Milwaukee, to visit the various mining machinery plants in the vicinity, and a stop will be made en route at the Fansteel plant. The entire metallurgical process will be shown, from the preparation and purification of the commercial concentrates, and including sintering the pulvurent metal obtained into homogeneous billets by the use of currents of enormously high amperage.

The National Exhibition of Chemical Industries is being held at the Coliseum, Chicago, the same week as the Institute Meeting. Members of the Institute have been extended an invitation to attend this exhibition.

By letters patent the capital stock of the Gurney Foundry Company is increased from $750,000 to $2,000,000.

Some Suggestions for the Standardizing of Guarantees for Coal Washeries*

By Sherwood Hunter.

*A paper read before the Midland Institute of Mining and Mechanical Engineers.

It is not unnatural that the purchaser of coal washing plant, involving the expenditure of so much money, should require something more than a mere assurance that the plant to be supplied will fulfill the conditions specified by the manufacturer. All contracts and agreements are, or should be, entered into after careful and mature consideration. Should, however, the conditions not be fulfilled, it is only remarkable how various little points which might otherwise have escaped observation an important part in enabling the buyer to establish his claim, or the seller to refute it. For this reason, contracts involving plant of considerable magnitude and value should be drawn up by experienced business men, capable of anticipating possibilities beyond the vision of the average technical expert. For the same reason, it is of equal importance that the conditions qualifying the terms of the contract should be carefully perused and clearly understood by the buyer. In quoting guarantees, the following terms are usually used:—

(1) Free coal in the dirt washed out;

(2) Free dirt in the washed coal, and occasionally;

(3) Fixed ash in the coal.

What is "free coal" and what does the word "free" represent? Free from impurities? Speaking scientifically there is no coal entirely free from impurities. Free from adherent impurities such as are visible to the naked eye, say, intergrown or laminated? In this case the term "detached coal" could be substituted for "free coal," but very few washery men would agree to this substitution, as there are coals with invisible natural impurities, with ash contents considerably in excess of the bulk of coal to be treated, even in excess of intergrown coal, which latter would not count, having a visible layer of shale attached and therefore would be excluded. Under such conditions coal of over 1.5 specific gravity might be included and counted against the contractor, whereas "intergrown" coal of possibly only 1.4 specific gravity would be excluded. Occasionally the combined term "free and detached coal" is used which would indicate that "detached" does not cover the term "free", otherwise this would read "free or detached."

In order to arrive at a solution one must study the process of washing, which consists of separating pieces of good coal, less good coal, bad coal, and dirt into two or three categories, say: (1) Coal and dirt; (2) coal, middles and dirt. The general practice in this country is to separate into coal and dirt only, and the additional class of "middles" occurs so rarely that its conclusion in this instance is hardly necessary. The good coal is of the highest specific gravity, and with increasing gravity the coal becomes more impure until ultimately the dirt remains. A representative coal shows the following separation test:—

Size in Millimetres.	Percentage of raw Coal	Ash in raw coal.	Floatings 1.35 solution.	Ash in same.	Floatings 1.40 solution.	Ash in same.	Floatings. 1.50 solution.	Ash in same.	Floatings 1.60 solution.	Ash in same.	Sinkings in 1.60 solution.	Ash in same.
Above 10	28.0	21.0	59.0	3.9	10.0	10.2	5.7	15.9	2.0	24.0	23.0	70.5
10 to 3	32.0	20.4	57.5	3.2	10.0	8.8	7.0	14.8	3.0	25.6	22.5	70.3
3 to 1	24.0	16.7	67.5	3.2	8.5	8.4	4.0	16.0	2.0	30.2	18.0	69.8
Below 1	16.0	14.3	74.0	3.0	6.0	8.9	30	17.1	1.0	29.0	16.0	67.4

and summarized we obtain:—

Per cent.	Per cent.		Ash per cent.	
	63.0	floatings in 1.35 cont.	3.35	
72.0				4.07
	9.0	floatings between		
77.3		1.35 to 1.4 "	9.15	4.90
79.5	5.3	1.4 to 1.5 "	16.0	5.50
	2.2	1.5 to 1.6 "	26.5	
	20.5	sinkings in 1.6	70.0	
	100.0		18.7	

If the yield from the washery approached the above figures one would naturally conclude that as far as the washery is concerned floatings in 1.5 solution is coal, and sinkings in 1.5 solution is dirt.

Having thus arrived at a definition of "coal" and of "dirt," how is "free coal" and "free dirt" to be interpreted in terms of specific gravity? On the basis of "free coal" being the floating in 1.35 specific gravity solution (generally used in the Yorkshire district), the dividing line between coal being 1.5, and 1.5—1.35=0.15, one would assume "free dirt" to be at an equal distance from that dividing line, namely, 1.5+0.15=1.65, or all sinkings in 1.65 specific gravity solution. Supposing floatings in 1.4 specific gravity solution is assumed "free coal," and 1.45 the dividing line for coal and dirt, "free dirt" would then be sinkings in 1.45+0.05=1.5 solution. These two examples are evidently extremes, and the proper figure probably lies somewhere midway. There remains still one other term, namely, "fixed ash" of the coal to be washed. One assumption is to select a piece of coal from visible impurities and to test it for ash, such being assumed the "fixed ash" in the coal. In the above separation test there are approximately:—

6 parts of coal containing 3.35 per cent ash.
1 " " " 9.15 " "
1 " " " 16.0 " "

Leaving out the coal containing 16 per cent. of ash, which may show visible impurities, the chances are:—

6 : 1 for a piece with 3.25 per cent.
1 : 6 " " 9.15 per cent.

Such a haphazard procedure is not likely to lead to any reliable conclusion in case of a dispute, and it is evident that with a yield of:—

63.0 per cent, the fixed ash is 3.35 per cent.
70.2 " " " 4.07 "
77.3 " " " 4.90 "
79.5 " " " 5.50 "

which again shows that the yield of washed coal must have a premier place in formulating guarantees.

It would be preferable to avoid the terms "free coal" and "free dirt" and arrange for the percentage

to be increased to allow for coal in the dirt, and dirt in the coal, ascertained in a certain solution at corresponding yields, the floating of which solution are "coal," and the sinkings "dirt."

Mr. Drakely read a paper on "Coal Washing: A Scientific Study," before the Manchester Geological and Mining Society on January 15, 1918, in which a number of tables are given showing the results of tests from washeries actually at work. In the lower part of each table are given "float-and-sink" percentages, which appear to have been taken in 1.45 specific gravity solution, judging from the ash contents of "floatings" and "sinkings."

Table No. 11.—There are 6.37 per cent. of sinkings in the small coal, about 2.5 per cent. in the nuts and peas, and 8.31 per cent. of floatings in the dirt. Allowing for 50 per cent. of fine coal and 50 per cent. of nuts and peas, the average would be about 4.5 per cent. of sinkings in the washed coal, so that the total difference between the theoretical results is 4.5 per cent. of sinkings in the coal, and 8.31 per cent. of floatings in the dirt, making a total difference of 12.81 per cent.

Table No. 12.—On a similar basis there would be about 8 per cent. of sinkings in the washed coal, and 9.1 per cent. of floatings in the dirt, making a total of 17.1 per cent.

Tablee No. 13.—There would be about 12 per cent. of sinkings in the washed coal, and 1.13 per cent. of floatings in the dirt, making a total of 19.1 per cent.

Table No. 16.—There would be about 7.8 per cent. of sinkings in the washed coal, and 11.62 per cent. of floatings in the dirt, making a total of 19.42 per cent.

Table No. 22.—There are 3.88 per cent. of sinkings in the washed coal, and 14.55 per cent. of floatings in the dirt, making a total of 18.43 per cent.

Table No. 25.—There would be about 6.4 per cent. of sinkings in the washed coal, and 9.1 per cent. of floatings in the dirt, making a total of 15.5 per cent.

The washeries tested were running for ordinary commercial purposes, and were evidently set to obtain a suitable product for the market, at a minimum loss. No doubt from the bulk of the washeries better results are obtainable, and guarantees could be formulated so that there should not be more than a certain percentage of floatings and sinkings in the dirt and coal at the yield obtained from the plant. This yield would of course, also depend upon the purity required for the washed coal, the percentage of floatings and sinkings in the dirt and coal respectively being ascertained in the specific gravity solution which determines coal and dirt. The total of floatings and sinkings might be fixed for average conditions at about 12 per cent., which figure would require to be increased with difficult coals, possibly up to 15 per cent. or even more, especially where a large proportion of material lies close to the specific gravity of the solution selected. The exact figure can be left to the constructor to decide, on the basis of his theoretical tests of an average sample of the coal with which the plant is required to deal. It should, however, be definitely stated in the guarantee whether the slurry is to be included with the washed coal or not. If excluded, the mesh of the slurry should be stated, and a minimum outlet from the washery agreed to if any changing of the washing water should be necessary.

The views put forward in this brief Paper are a result of the outhor's own personal experience, and are not intended to be taken dogmatically. It will doubtless be generally agreed that a uniform standard of efficiency is most desirable, with a clear understanding as to the meaning of the guarantees.

RESEARCH WORK ACCOMPLISHED BEARING ON REDUCTION OF CANADIAN LOW-GRADE IRON-ORES.

In the Annual Report of the Honorary Advisory Council for Scientific and Industrial Research, Dr. A. B. Macallum, the administrative chairman, states with reference to the reduction of low-grade iron-ores native to Canada:

"In spite of the handicap experienced in the lack of researchers, some effective work was done. The investigation of the reduction of low-grade iron ores under the supervision of Professor Stansfield, of McGill University, has advanced to a stage which promises important results bearing on the utilization of ores of this character so abundant in Canada. There is but a small supply of high-grade iron ore in the Dominion, which is emphasized by the fact that 96 per cent of all the iron ore smelted in Canada is imported, this importation including, of course, that obtained from Belle Isle, Newfoundland. The total quantity of high-grade ore of the globe available is, through its use for producing iron and steel, diminishing at a rate which makes its exhaustion a not far-distant event, and in consequence it will eventually be necessary to turn to those of lower grades for the supply of ore for the industry. If the smelting could be effected on an industrial scale at a reduction in the cost which would offset the disadvantages at present attendant on the utilization of these lower grade ores it would make available, immediately or in the very near future, the immense quantities of such ores in Canada. The Research Council regards the solution of this problem as of very great importance to Canadian industry and as justifying a protracted experimental investigation carried on on a large scale."

TRADE ENQUIRY

Enquiry is made of the name of any Canadian exporter having English representatives who can supply the ordinary kitchen range used in Canadian households fitted to burn Scotch splint coal.

AMERICAN INTERESTS ACQUIRE PERUVIAN VANADIUM DEPOSITS

"Boston News Bureau" announces that strong United States interests, including Messrs. Schwab, Ryan and Replogie, are forming the Vanadium Company of America, Inc., and have acquired the largest known deposits of vanadium in the world, situated in the Peruvian Andes. It is stated these mines contain ninety-five per cent of all the known vanadium reserves, and that the ore carries an exceptionally high metal content.

Vanadium Co. of America is now selling its product ferro-vanadium at $5.50 a pound, compared with recent price of $3.50 and pre-war average price of $4.50. Company has 36,000,000 pounds of contained vanadium in its Peru mine actually in sight. Engineers estimate total vanadium in mines at over 100,000,000 pounds.

The Canadian John Wood Manufacturing Co., New Toronto Factory

By FRANK C. HAMILTON.*

For a number of years the manufacture of Galvanized Steel Range Boilers has occupied the attention of some of the largest firms in the United States and Canada. The first Range Boiler produced was of rivited construction, and depended on galvanizing to make the joint tight between the rivets since the metal used, ordinarily No. 13 U. S. Standard Gauge, was entirely too light for caulking. Then a boiler was produced which was riveted in the same way and molten brass and flux were run in the riveted seam before the galvanizing process in order to assist the joint in its tightness against water pressure.

Next the Cold Weld or lock seam was developed, and enjoyed considerable popularity among the trade for a number of years. Then came the welding by the use of the oxy-acetylene torch and this process has been developed to a large extent.

In 1901 the "electric weld" was developed by the John Wood Manufacturing Company of Conshohocken, Pa., and has under every condition of service and under every test proved its superiority over the other methods of making the joint.

In this "Electric-Welding" process the sheet of steel rolled in a cylindrical form is drawn through a specially built machine under electrodes which supply low voltage high amperage electricity across the joint in the cylinder. This current raises the temperature of the steel, on the two edges to be joined, to welding heat and as pressure is applied by the rolls of the machine the weld is completed. This weld in no wise alters the chemical composition of the steel and does not therefore introduce any of the impurities, carbon, sulphur, etc., which are put into the steel with injurious effects by other welding processes.

The demand for Electric Welded goods has steadily increased as the public became aware of its superiority over the other methods of manufacture. In 1901 the demand was only about 40 or 50 boilers per day. Now, 60 per cent of all the boilers required by the American plumbing trade or 2,000 per day are produced by this method and the factory is in continuous operation day and night to meet the demand.

The field for the "Electric-Weld" is not confined to Range Boilers alone, but the joint is used with excellent success on all types of pressure and storage containers. The process of manufacture has been approved both by the Ordnance Department, United States Army and the Bureau of Ordnance, United States Navy and during the Great War the John Wood Manufacturing Company furnished the American Forces with upwards of 1,000,000 Cartridge Storage Cases for Propellant Charges for Artillery Ammunition, made by this method. These cases range from 6in. diameter by 26in. long to 18in. diameter by 108in. long and were used to hold the silk bags of powder for guns and howitzers from the 155 MM Mobile Howitzer up to the 16in. Coast Defense Rifle.

Boilers and Tanks of this construction have been built and shipped to all parts of the world and after exhaustive tests, Dr. Kennedy of London, the famous English metallurgist has placed a value of 96 per cent on the efficiency of this weld. This figure is in comparison with a value of approximately 65 per cent for gas welds and lower values for riveted joints, depending on the size and pitch of the rivets.

The accompany schedule gives an idea of the strength of the weld, the tests noted having been taken on steel of the following physical properties.

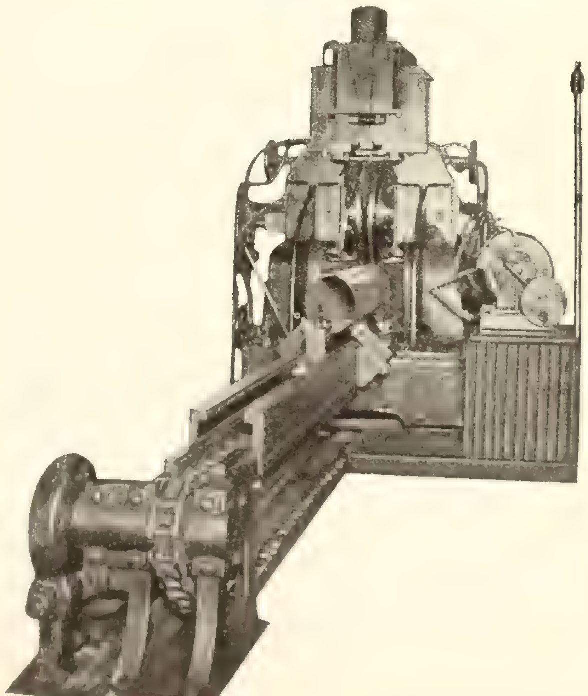
Tensile strength, 52,000-62,000.

Yield point min., 0.5 Tens. Str.

Test on "Electric-Weld Seams—Dec. 4, 1916.

Made in Laboratory of The Alan Wood I & S Co., Phila., Pa.

Test No.	Section Width.	Section Thickness.	Original Area	Yield Point lbs./sq. in.	Ultimate lbs./sq. in.	% Elong. 8″	% Elong. 2″
1	1.500	.101	.151	42390	61930	17	34
2	1.480	.071	.105	39530	55720	11	16
3	1.485	.070	.104	39430	56740	12	16
4	1.475	.068	.100	39000	56500	18	36.
5	1.485	.101	.150	38670	61010	17	34
6	1.480	.067	.099	38390	56060	11	16



Electric Welding Machine.

* General manager of Canadian John Wood Manufacturing Co., Toronto.

These tests were made on a regular tension machine with American Society of Testing Materials standard specimen test pieces having the weld running horizontally across the centre of the specimen.

In the manufacture of "Electric-Weld" Range Boilers, the steel sheets as they come from the rolling mills are sent direct to the trimming shears which cut the sheets to exact size and from there to the sand blast which by means of sharp sand, forced through nozzles under high air pressure, removes all corrosion, mill scale, etc., from the edges of the sheets in order to give an absolutely clean surface for the Electric Welding of the long horizontal seam.

Plant of the Canadian John Wood Manufacturing Co., Toronto, Ont.

From the sand blast the bending rolls form the sheet into cylindrical shape preparatory to the welding operation. The shell is then welded at a speed approximating five feet in forty seconds, and the boiler passes on down the shop where the heads and bottoms are brazed in mechanically and the pipe connections are set into place under extremely heavy hydraulic pressure.

The boiler is now completed in the black and is rigidly tested under hydraulic pressure for any defects.

To protect the product against the action of corrosive elements the boiler is next galvanized, inside and out, by the "hot dip" process insuring a full and complete coating of zinc for every part of the exposed surface.

After galvanizing as an added precaution the boiler is again tested by air pressure and is ready for shipment to the customer.

The Canadian John Wood Manufacturing Company Limited, has purchased a plant comprising 3¾ acres situated at Hillingdon Ave. and the Grand Trunk Railway in Toronto, Ontario, for the manufacture of Range Boilers, Air Tanks, Storage Tanks, Gasoline Tanks, etc., by the use of this electric welding process.

In addition the company will install the latest type machinery for metal working including trimming shears, bending rolls, punches and heavy hydraulic equipment for the formation of heads and bottoms. A galvanizing shop will be equipped and installed which will contain a pot 30″ x 36 x 101″ which will be capable of handling a general line of material to be galvanized.

The plant will be prepared to manufacture all types of welded steel tanks and containers by both the electric and oxy-acetylene torch method. The plans for the operation of this shop are rapidly nearing completion, and it is expected that production will be begun sometime in October.

A NEW CANADIAN IRON AND STEEL INCORPORATION.

The following announcement has appeared in the newspapers regarding what appears to be one of the most important incorporations of recent date in Canada.

"A charter for $8,000,000 was issued on August 13, to the Consolidated Iron & Steel Corporation, Limited, a company of Detroit and Toronto parties engaged in the mining business. The company is essentially Canadian, with head offices at 20 King Street East, Toronto. They own two large deposits of proven iron ore lands and it is their intention to proceed in a large way with their development.

The company has opened a large hematite mine on the C. N. R. in the county of Leeds, 25 miles north of Brockville at Furnace Falls, where they have 1,500 acres. The early settlers erected a smelter at this place 110 years ago and it was operated in a primitive way the ore being ground out by water wheel. It still retains the name given to the place at that time. This was in the days when Lake Superior and Pennsylvania ores were almost unknown. The City of Brockville has offered inducements to the company to build a pig iron smelter there and it is being seriously considered as there is a surplus of electric energy at a low rate. As the mine has excellent transportation facilities, ore can be shipped by the St. Lawrence. either west to Canadian and United States markets or east to Montreal, Ottawa and European markets.

Their other property consisting of 2,500 acres is located at mileage 182 on the Algoma Central Railway. This has been gradually developed since it was discovered in May, 1911. Up to the present time permanent camps have been built and diamond drilling has been carried on from November, 1917, to July 1918, proving up large deposits of ore to a depth of 500 feet. Prominent iron ore engineers reporting on this property estimate the tonnage at from 800,000,000 to one billion tons of ore. The ore is free from titanium and low in phosphorus and sulphur. Work on both properties is now being carried on, thousands of tons already being piled up at the Furnace Falls mine ready for shipment."

"Iron & Steel" understands that one of the properties owned by the new company consists of a consolidation of 78 mining claims, covering some 3,000 acres situated north of Goudreau Station on the Algoma Central Railway, being about 40 miles from the ore docks of Michipicoten Harbor and adjoining the Josephine Mine. Some surface stripping and trenching was done on this property under the direction of C. M. Daimpre in 1918, and it is stated the property has since been drilled to the 650 ft. level. The Josephine

Mine, adjoining has been drilled to a depth of 1,690 feet, finding ore of good quality.

With regard to the Dreany claims the Ontario Bureau of Mines Report for 1915 states:

"**Iron Mountain, or Dreany Claims**: This range is probably the longest in the region, and is located near the contact of the Laurentian and Keewatin formations. It crosses the Algoma Central Railway about four miles north of Goudreau Siding. The range is known to extend about four miles west of the railway, and it is said to extend for about the same distance to the east. The ore is, so far as seen, magnetite, which is interbanded with quartz, epidote rock and garnetiferous hornblende schist.

"A striking feature of portions of the deposit is the presence of large quantities of epidote, which, in places, is the predominant mineral in the adjoining rock, and at times is the principal mineral interbanded with the magnetite. In places, the banded material is badly brecciated, but this does not extend to the entire formation. This deposit is similar to the iron deposits near Dryden, though epidote is not so prominent in the latter deposits."

With regard to the Josephine Mine, the close proximity of which has been noted, the Report of Lindeman on "Iron Ore Occurrences in Canada" states that brown hematite, such as is produced in large quantity by the Helen Mine, occurs at a number of points in the Michipicoten District, but the only other place at which it has been found in workable quantities is the Josephine Mine. Here, some 850,000 tons of ore, a large part of which is said to be of Bessemer grade, averaging 59 per cent in iron, is stated by the owners to have been proved by diamond drilling. "The deposit, however, has not yet been proved to the producing stage, though preparations for doing so were under way until interrupted by the European war."

The company's other deposit is a hematite property of 1,500 acres at Delta, Ont., on the Canadian National Railway, 25 miles from Brockville on the St. Lawrence River. The ore is stated to analyze 55 per cent iron and to be from objectionable constituents.

The progress of this new company will be followed with keen interest. It is not understood whether this new company intends to use electrical power to any large extent for smelting, or whether it will manufacture or buy coke in the customary manner, but in this connection it is interesting to note that the Consolidated Mining and Smelting Company of Canada is reported to have acquired a portion of the Webb McCarthy-Miller gold claims near Goudreau, and that electric power for mining purposes is to be obtained from the Michipicoten Power Company.

CANADIAN IRON MEN.

F. E. Lucas, the Economy Engineer of the Dominion Steel Corporation, is entirely a home-made product. His service with the Dominion Steel Company covers the life of the Sydney plant, and his practical experience extends to most parts of that extensive industry, but has been chiefly concentrated upon the by-product coke-ovens and coal-washeries of the company. Mr. Lucas is a graduate of McGill University, but he is more particularly a graduate of the Dominion Iron & Steel Company's experience with the treatment of Cape Breton coals for metallurgical purposes, which he has supervised for a decade or more, and concerning which, naturally, his knowledge is unique. During Mr. Lucas's operating career he has seen the technique of coal-washing, of coke-open practice, and by-product recovery develop from very small beginnings on this continent to its present imposing stature. The Sydney coalfield saw the first coal-washeries and virtually the first by product ovens erected in connection with steel manufacture in America, and throughout the years between, and particularly during the unprecedented developments of the war period, the coalfield has kept pace with, and in some notable instances has made the pace for progress in coke-oven practice on this side of the water. In all this, "Frank" Lucas has played the prominent part for which he is so well fitted.

During the war period, when the necessity for toluol was great, and the technology of its production not so well understood here as it was in Germany, Mr. Lucas's services were especially valuable, and he supervised some extremely rapid plant installations designed by recover toluol in as large quantity as possible in the quickest possible time. The war-time "stunts" and romances were not all staged in France.

Mr. Lucas, in addition to his professional abilities, has developed a flair for arranging War Loan parades and patriotic demonstrations, which up till recently he had concealed, whether from innate modesty or lack of necessity, we do not know.

Recently Mr. Lucas was made Economy Engineer of the Dominion Steel Corporation, a position for which he is eminently fitted by reason of his knowledge of the characteristics of Cape Breton coals. The real problem of the Sydney Steel Plant is the production of the heat required for metallurgical processes at a reasonably cheap cost, and this of course is a problem of coal.

F. E. Lucas, Economy Engineer, Dominion Steel Corporation.

STEEL CONSTRUCTION APPLIED TO SPECIAL CONDITIONS.

Warehouse for Iron and Steel Storage.

By Albert S. Spencer

The Warehouse described herein, and illustrated in Figs. 1 and 2, is remarkable for its great height, and, perhaps striking in its design owing to the method adopted to secure stability against wind loads.

The construction of the building is that of a steel-framed structure having a roof covering of asbestos slates on boards with the necessary roof glazing, and side and gable covering of corrugated sheets. The building is 378 ft. 6 in. long and 236 ft. 8 in. wide overall—in two spans of 118 ft. 4 in. by 62 ft. high to the eaves, and about 98 fet. high to the ridge. Longitudinal stanchions are at 94 ft. 7½ in. centres, and the roof trusses are at 15 ft. 9¼ in. centres and are carried by lattice type roof girders.

The exceptional height of the building was necessary to give sufficient head room for locomotive jib cranes which are used for handling the steel inside the building, and which have long radius jibs to facilitate the moving of the material.

1.—Warehouse for Iron & Steel. The purpose for which this building was required necessitated an erection of unusual height, requiring special provision for resisting wind-pressure.

The major principle of resisting the wind pressure, whilst hardly a novel one, is, at the same time, one not generally adopted, and is one which so affected the general arrangement of the steelwork as to make the design a striking one. The requirements of the Architects, Messrs. Chas. Heathcote & Sons, Manchester, necessitated investigations as to the most economical means of resisting the enormous wind pressure to which a building of such large dimensions in an exposed position is subjected. The method adopted for resisting this pressure, as will be seen from the accompanying illustrations, was that of transmitting all side-wind pressure to the gables, through a series of bracings in the roof—in the plane of the bottom ties of the roof principals—the wind load on each side stanchion being transmitted, equally, to the foundation an to the eaves. The reaction for at the ground level was obtained by a massed concrete foundation of a size necessary to provide sufficient area of resistance from the ground to prevent any sliding in a lateral direction.

That portion of the load transmitted to the eaves, together with the horizontal component of the wind force acting on the roof, was transmitted to the main stanchions by means of the longitudinal lattice girders situated at the eaves level, from whence the horizontal component of the wind force was concentrated at the corners of the building at the eaves level, by means of a continuous lattice girder, one boom of which was at the eaves and the other at the valley, the web members, extending from eaves to eaves of the main roof main ties of the roof principals and diagonal members, extending from eaves to eaves of the main roof trusses. This wind force was then transmitted along the gable frame at the eaves level and finally taken down to the ground level by means of suitable diagonal ties.

Somewhat similar treatment was followed in connection with the wind force acting on the gables, excepting that the reactions on the gable stanchions acting at the eaves line were transmitted to the main gable stanchions by means of a lattice girder situated at the eaves level, from whence the force was transmitted in a longitudinal direction by roof girders. That portion transmitted to the valley roof girders was taken to the sides of the building by means of diagonal braces, so that the whole of the gable wind force transmitted to the eaves level was finally carried to the foundations by means of diagonal bracing in the sides of the building. It may be particularly noted that longitudinal roof girders were placed in the valley to resist the horizontal component of the wind force acting on the leeward side of the roof.

The approximate weight of steelwork used in the construction of the building was 1000 tons.

Lens, in April, 1919.

Shaft No. 4 at Courrières, in the Pas de Calais.

Shaft No. 11, at Bethune.

Surface Plant at the No. 4 Shaft, at Courriere.

Steel Plant at Longwy.

Rolling Mill of the Longwy Steel Plant.

Steel Works at Mont St. Martin.

Shaft and Plant at Bethune.

The roof principals were lifted into position by means of a steel derrick specially constructed for the purpose, and were joined together in the air.

The approximate weight of the steelwork used in the construction of the building was 1000 tons.

The structure was designed, manufactured, and erected by structural contractors to the requirements of the architects.—From Quarterly Journal, Steel Structural Section British Engineers Association.

MODERN STEEL BUILDINGS.

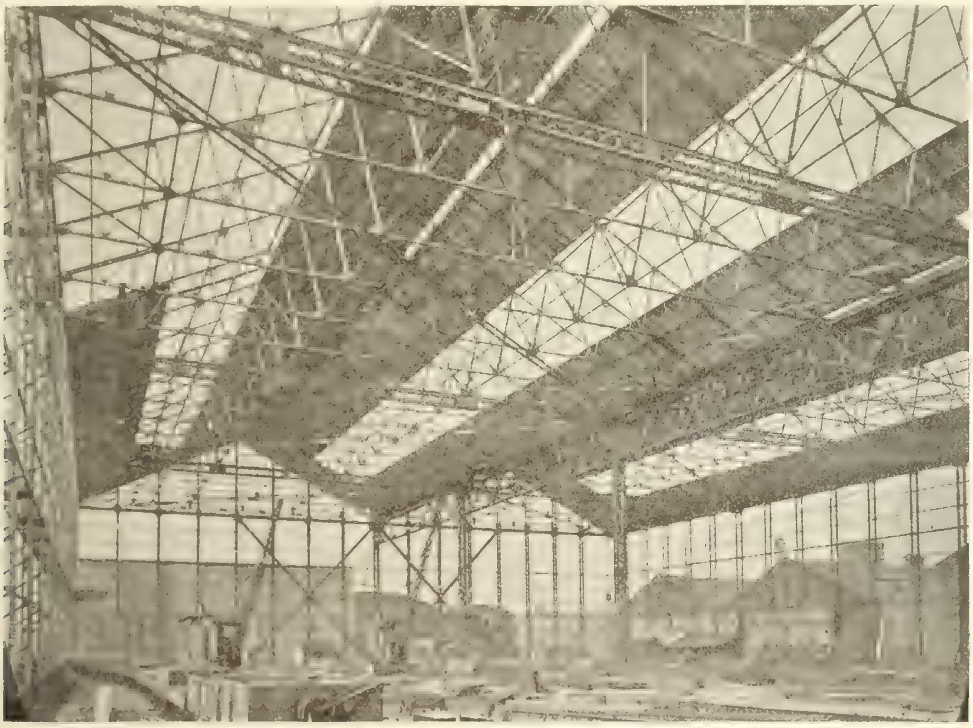
The Application of Expert Knowledge.

The advanced standardization system that has pervaded almost every sphere of the engineering world is now enterprisingly applied to many varieties of steel constructional work, and particularly as it refers to the framework of buildings. It is the logical outcome of much careful study of the subject and one of which the pioneers have every right to be proud.

The amount of detail work goes into the making up narrowed to a **type** rather than a **unit**, and thus, under the new system, erection proceeds apace, no longer dependent on a part that may come to light to-day or to-morrow. Nor is this the sole advantage, for the manufacturer is enabled to do that for which he is always, or should be always, striving, viz., production of identical parts in quantity.

All this is not attained without the most careful regard to design, and it is promising to note that so successful have been the results obtained from steel constructional work along the lines indicated, that not only have the parts of a single building been made interchangeable, but parts have been designed having more or less universal adaptability, being made common to buildings even of widely divergent character.

The influence of the cost of production is marked, but it is more pronounced in certain types of structure than in others. However, a general moderate reduction in cost of manufacture, has done something to counteract the present universally high prices.



2.—Great height of this structure is pronounced in comparison with surrounding buildings. Approximately 1,000 tons of steel work was used in this erection.

of a steel-framed erection is hardly credible to the lay mind, and when frames or complete sectional buildings of this variety are sent abroad—sometimes in many hundreds of parts—not infrequently considerable difficulty is experienced in the erection, and this cannot be wholly attributed to the totally unskilled labour which too often in some remote part of the earth's byeways forms the only hope available. By the new system the majority of such troubles are lessened if not entirely eradicated.

The old method of erection was by means of carefully coded plans, each individual cypher, representing some correspondingly marked part of the structure somewhere amongst hundreds of other parts, many of very considerable weight. Perhaps a desired unit of the structure is a key piece, and so the whole work is delayed until this key piece is found. Now supposing that there are a number of parts, each precisely of the same character, obviously the field of search is

When considering the question of cost, it is interesting to note that, prior to the War, prices were largely in favour of buildings almost entirely constructed of wood, but the increase of approximately 400 per cent in the price of timber has equalized the demand, which, when cost is the only factor to be considered, favours the steel erection. In some cases composite structures have been found satisfactory, whilst in others, specifications demand steel and iron even down to such items as window frames and similar fittings, but as regards the roof covering and material for the walls, asbestos, cement sheeting, and tiling is now almost exclusively used in place of corrugated iron.

It may not be out of place, and will certainly be of general interest, to briefly state some of the conditions which become essential features of many specifications, rendered absolutely necessary by the peculiar demands common to certain localities.

Primarily comes the dread white ant and Teredo Navalis; the astonishing capacity for destruction possessed by the white ant is too well known to need description here, but a description of the methods for combating the scourge is always instructive.

A system still frequently met with, and at one time, almost universally adopted, was that of raising a building some few feet above the ground by means of steel uprights, to each of which was attached a metal cup completely encircling the support. The cups were filled with paraffin or some other noxious liquid which had the effect of completely insulating the building. Evaporation and the formation of a film of dust was frequently the cause of permitting the ant an entrance and so further attention was drawn to the subject, and other means devised. Some measure of success was gained by the use of uprights of wood suitably treated with liquid, poisonous to the ant, and then creosoted, and for a time this proved more or less satisfactory, but results from this method were not altogether permanent.

Careful study of the habits and anatomy of the ant was then made with a view to solving the problem and it was found that by inverting the cup, already mentioned, and grinding the edges to a sharp finish, an impassable and permanent obstacle was offered to the white ant, the articulation of its body being of such a nature that the sharp edges rendered negotiation of the cup impossible, and with every attempt a fall to the ground was inevitable.—From Quarterly Journal, Steel Structural Section British Engineers' Association. July.

STANDARDIZATION OF STRUCTURAL STEEL IN AUSTRALIA.

A conference which had for its object the standardization in Australia of structural steel sections has concluded its work at Melbourne.

The conference was attended by representatives of the producers and users of structural steel, including public departments of the States and the Commonwealth, and engineering and architectural institutes throughout Australia.

The object of the conference was to bring about changes in the sections to meet the conditions of manufacture in Australia, and also to endeavour to agree upon a reduction in the number of steel parts that users in Australia would demand from makers and thereby reduce the cost by eliminating those for which there is little demand.

It is stated that the result of the conference has been satisfactory, and that a series of structural shapes has been defined which will enable Australian manufacturers to meet practically the whole requirements of the Commonwealth. A certain number of sections is to be allocated to each steel-rolling mill, which they will manufacture exclusively and thus be ensured a quick turnover on their outlay and users a constant supply of standard sections.

COSTLY PROCRASTINATION.

Instances are occurring repeatedly where manufacturers have planned increased wages or shorter working hours or both, but have put off the announcement to their workers until a demand has been made upon them, or, which is almost as bad, until the unrest that precedes a demand has made itself felt. As a consequence the employees believe their better pay and better hours came to them because the owners felt compelled to grant them and otherwise would have done nothing whatever. Procrastination of this sort is costly in loss of good will, a loss the more irritating because it is unjust.

The average worker can seldom see any good reason why owners should voluntarily make any concession which looks as if it reduced profits They do not grasp the fact that apart from any feeling of friendliness for them, it is usually absolutely necessary for a management to sense the trend of the times in such matters as wages and working hours. Otherwise it is at a serious disadvantage. When good labor is scarce as it is to-day, a plant cannot expect to compete and add to its force, everything else being equal, if other works in the district offer more attractive pay. Employees seem to lose sight of the fact that supply and demand govern hours and wages collectively as applied to a whole works, just as this law decreases or increases their individual earnings, and that owners often act accordingly without the need of threat or coercion.

Another thing many workers do not grasp. The cold and ruthless owner is almost a mythical character in American manufacturing industry. The owner is a business man. He will fight if he has to. But many a managing head regards his working force as a big family of which he is the head, and while he aims to treat each individual according to his deserts many fare much better than they realize. Owners usually have a pride in their establishment, which of itself impels them to look after the welfare of all the people connected with it. And between pride and friendliness employees frequently receive benefits which are really uncalled for and which at times are not warranted by the condition of business.

Even where the workers realize something of this, when a concession is made following demand, it is hard to convince them they are simply getting what had already been planned. Sometimes the result has been encouragement of demands for more, which would never have been made, probably, had the announcement of the change been made with promptness.—The Iron Age.

TATA IRON & STEEL CO. IN MARKET FOR STRUCTURAL STEEL.

It is stated that this large Indian steel enterprise is asking tenders in the United States for 20,000 tons of structural steel.

Tata Iron & Steel has been making plant extensions involving blast furnaces and finishing mill installations and the structural steel, for which inquiries are out, is needed to house the new units. The Indian concern now has three blast furnaces with annual production capacity of about 325,000 tons of pig iron and open hearth steel-making capacity for about 175,000 tons with corresponding finishing mill units, covering an output of plates, rails, bars, sheets and miscellaneous materials.

Further substantial extensions of blast furnaces and steel-making departments and finishing mill units are planned. In the case of iron and steel-making departments these proposed extensions, as planned, will add upwards of 70 per cent of the present capacity.

A. R. Roberts, lately of the firm of Burns and Roberts, Toronto, has severed his connection with the firm and opened offices under his own name at 201 Bank of Hamilton Building, Toronto. He will handle contractor's power plant and railway equipment.

Company Notes

ALGOMA STEEL ANNUAL REPORT.

The annual report of the Lake Superior Corporation, of which the Algoma Steel Corporation is a chief subsidiary, showed steel earnings from operations of $5,035,032, compared with $6,001,891 the previous year. The Steel Corporation, however, in addition to paying a dividend of 7 per cent on preference stock for the year ended June 30, 1915, amounting to $700,000, paid the sum of $350,000 on account of preference dividend for the year ended June 30, 1916. At the same time, it carried forward a balance of $1,433,875, compared with $764,038 the previous year.

The Steel Corporation's financial position has been improved, as current assets stand at $13,834,842, compared with $11,147,259 the previous year, while current liabilities are but $2,449,790, compared with $3,059,826 in 1918. Total assets of the Steel Corporation show little change at $55,280,830.

Production by the Algoma Steel Corporation, as compared with the preceding year, was as follows, in tons:

	1917-18.	1918-19.
Coal imported	995,064	880,591
Ore imported	761,082	700,510
Limestone produced	321,485	296,812
Coke	379,040	406,398
Pig iron	314,188	336,657
Steel ingots	499,712	414,932
Steel products	329,438	322,011

President Wilfred H. Cunningham in reviewing conditions says that the change from the war to peace conditions naturally resulted in a stoppage of the manufacture of shell steel and steel for munitions purposes generally.

"Towards the end of the year, the mills resumed the rolling of normal products in the shape of steel rails, rail fastenings, merchant-bars, shapes, etc. Up to the time of making this report, business has not been plentiful, and for the last few months the mills have been operating at about half capacity."

New Structural Mill.

Mr. Cunningham believes that repairs and replacements orders for steel must soon absorb considerable quantities. The long-cherished idea of a structural mill, he says, should now be dealt with, and plans are in preparation for a new universal mill consisting of a 40-inch blooming mill, 36-inch rougher and three stand 28-inch combination structural and rail finishing mills. These works, the directors believe, would have sufficient business and they are vital to the continued success of the steel company.

A scheme for financing the undertaking will be submitted to stockholders at an early date. In the meantime, the rail mill is being extended to care for such structural steel up to 15-inch beams and panels as may be required by the market.

Following are some of the salient items from the consolidated balance sheet of the Corporation, so far as they relate to the steel operations.

Algoma Steel Corporation.

Net earnings	$5,035,032	$6,001,891
Pfd. dividends	1,050,000	700,000
Current assets	13,834,842	11,147,259
Current liab.	2,449,790	3,059,826
Balance P. & L.	1,433,875	764,038

Dominion Iron and Steel Company.

The production of the Dominion Steel Corporation in August was as follows:

	Tons.
Coal, Cape Breton and Springfield combined	274,781
Pig Iron	12,704
Ingots	18,637
Rails	1,604
Wire Rods	3,391
Nails	788
Sulphate of Ammonia	172

The larger quantity of ingots, when compared with pig-iron production, is occasioned by the fact that during August the blast furnaces were discontinued in operation.

The rod mill is working single shift, and the wire and nail mills are working to capacity.

Two of the blast furnaces have been re-lined, and the remaining four are in excellent condition, so that whenever conditions will permit of the resumption of blast furnace operation, very good performances should be possible.

Work is being given to all the employees who require it on the construction of the plate mill, and it is understood that some 4,000 men are employed on the plant, this being not far from the normal number at work when production is in full swing.

The cessation of the blast furnace operation lessens the coke requirements, so that a falling-off in the output of this department, including by-products, will now take place.

The obtaining of export business is being made more difficult by the aggressive under-selling of United States steel interests, and by the uncertain and depressed state of exchanges which makes quotations against future deliveries hard to calculate.

The re-delivery of the requisitioned ships of the Corporation, which have now all been returned except the Rosecastle and the Daghild, will enable the Coal Company to resume Montreal shipments to an extend limited by the short remaining portion of the season of open navigation. A quantity of between 400,000 and 500,000 tons of coal may be landed in the St. Lawrence markets before the close of the season, which will be the largest shipment from Nova Scotia since 1915.

The labour difficulties at the collieries have been much exaggerated, and erroneous ideas are in circulation because of the prominence given by Montreal newspapers to irresponsible statements credited to the miners' leaders. The aims of the leaders, which are largely advertised for political effect, are very different to the achievements actually obtained, which are conditioned by the economic limitations of the industry in Nova Scotia. The agitation for a five days week, for large increases of wages, for shorter working hours, and the supposed attitude of the labour leaders in Nova Scotia towards the course of the Government in prosecuting the Winnipeg strike leaders, are matters that have been given undue prominence by Upper Province newspapers who do not understand the local peculiarities of Nova Scotia, and who apparently do not know how to discount the utterly preposterous reports and opinions that are credited to Nova Scotia sources of information. The real object of some of the hyperbolic utterances either made or imagined to be made in Nova Scotia by the labour leaders is to counterpoise the request which some of the smaller coal operators must shortly make for lower wages and increased production. These smaller operators have no reserves to draw on, and are so

much in debt already that they cannot bear further losses, so that if they do not obtain more favorable operating costs they must close down before long. Some of these small companies, if they once close down, will not re-open within a measurable future.

BALDWIN'S CANADIAN STEEL CORPORATION.

Announcement is made that the British Forgings plant at Toronto, which was recently bought by Baldwin's, Ltd., of Swansea, Wales, will be operated as Baldwin's Canadian Steel Corporation, Ltd. The new firm will be capitalized at $10,000,000, it is said, and will employ 2,300 men within a year.

E. L. Cousins, chief engineer of the Toronto Harbor Commission, who negotiated with the company on behalf of the city and the harbor commission, states that A. M. Russell, of Hugh Russel & Sons, Ltd., Montreal, was largely instrumental in persuading Baldwin's to establish a plant in Canada. Mr. Russel went to Wales for the purpose of interesting his principals, with the result that J. C. Davies, managing director of Baldwin's, Ltd., came to Canada, accompanied by D. E. Roberts, consulting engineer of the company, and the deal was consummated soon afterwards. Mr. Russel will be president of the new Canadian corporation.

Within a few months the new firm will begin the manufacture of tin plates, black sheet and galvanized sheet. The British Forgings plant, located in the Toronto Harbor Commission's eastern harbor terminal, is 127 acres in extent, with 1,600 lineal feet of 24-ft. dockage. The new company also holds an option on 79 acres of additional land.—The Canadian Engineer.

STEEL PLANT FOR GODERICH.

After several weeks of negotiations a site has been secured and other preliminaries settled for the location of the Lake Huron Steel Corporation at Goderich. The site is at the south end of the town and partly in Goderich township, and comprises 250 acres along the shore of Lake Huron. Surveyors are already at work.

Among the men interested are: J. J. Mahon, Newark, late Chief Inspector Imperial Munitions Board, formerly of the Crucible Steel of America; J. A. Durfee, Pittsburg, late general manager of the British Forgings Company, Toronto; J. C. Jones, Cleveland, President of the Cleveland Steel Co.; Charles R. Talbot, Detroit, vice-president of the National Bank of Commerce, Detroit; Harry S. Hall, Detroit, general manager of the Lewis Hall Iron Co. and president of the Hall Motor Truck Co.; C. F. Megow, St. Paul, President of the Charles Megow Tractor Co., recently of the Ford Motor Co., Detroit; Bert H. McCreath, Toronto.

The company promises to spend more than two million dollars in the next twelve months and an additional six millions in the second year in establishing its plant, which will include six electric furnaces and other special equipment for the manufacture of high-class steel products.

BRITISH COLUMBIA IRON COMPANY.

Much interest is being shown in the Kootenay in the big hematite deposit that is being traced on Thompson Creek, according to visitors from Creston. Work has been in progress on the group of 40 claims ever since spring, G. A. M. Young, of Creston, being in charge of a crew of 12 to 15 men, who are engaged in trying to define the boundaries of the deposit. The group is the property of the British Columbia Iron Company, Ltd., the directors of which are F. L. Hammond, Mr. McLaws of Winnipeg, P. G. Ebbutt of Creston, and E. C. Wragge of Nelson.

Mr. Wragge made the following statement regarding the property:

"The property of the British Columbia Iron Company, Ltd., consisting of about 40 claims, is situated about three miles west of Kitchener, extending in a belt north and south which crosses the C. P. R. line at Thompson Creek.

"When I visited the scene last fall, the deposit as then exposed was of comparatively small extent.

"Considerable work was done last fall, and this season Mr. Young has been working ever since the spring, tracing the deposit by means of surface trenching. The result is that we have proved quite a large body of hematite ore. The ore is from 60 to 65 per cent iron.

"There is now no doubt that our hematite deposit is a southern extension of the known belt of hematite that the C. P. R. Company and C. P. Hill control on Goat River.

"What we have discovered so far is very satisfactory. There are some other points to determine, however, before we can assert that we have a commercial proposition. It will take diamond drilling to bring out what we want to know, but that step is not yet being discussed."

FRENCH DEMAND FOR CANADIAN CUTLERY.

Mr. Philippe Roy, Commissioner-General for Canada, in Paris, France, writes to the Department of Trade and Commerce, at Ottawa, that a firm of importers in Paris desires to be brought into communication with Canadian manufacturers of table cutlery such as knives, forks and spoons (large and small), in aluminum and in ordinary metal. Prices F. O. B. Canada. Cheapness is one of the particular points, but a higher class article can also be quoted. Catalogues, which are requested in duplicate, are to be sent direct to Philippe Roy, Commissioner-General for Canada, 17-19 Boulevard des Capucines, Paris, France.

RECENT TRADE INCORPORATIONS.

The British Foundation Ovens, Limited, capital stock $15,000,000, with head offices at Montreal, have been granted letters patent, authorizing them to carry on the trades of ironmasters, briquette makers, steel makers and converters, colliery proprietors, coke manufacturers, miners, smelters, engineers and tin plate makers in all their respective branches, according to the list of incorporations gazetted in this week's Canada Gazette. The directors named are all of the State of New York.

Letters of incorporation are granted in Canada to citizens of South Bend, Indiana, under the name of Canadian Oliver Chilled Plow Works, Limited, to manufacture plows, etc. Capital stock $20,000, and chief place of business at Regina, Sask.

Handley Page, Limited, is incorporated by Harold William Workman, Admiral Mark Kerr, and others with a capital of $2,500,000, with chief place of business at Morrisburg, Ontario, to manufacture and deal in aircraft.

The Robbins & Myers Co., Springfield, Mass., will locate its Canadian plant at Brantford, Ont., where it recently purchased a site of 10 acres and will erect a plant to employ 350 hands. The company manufactures small electric motors and fans, etc.

The Fisher Body Co., Detroit, will build a five-storey factory at Windsor, Ont., for the manufacture of closed automobile bodies, which will employ 200 men when completed. The company has a plant at Walkerville, Ont., where it manufactures open automobile bodies. The new plant will cost $350,000.

The Muskoka Foundry, Ltd., Bracebridge, Ont., has been incorporated with a capital stock of $70,000 by Charles E. Lount, Alexander C. Salmon, Albert Cooms and others.

The Savold Tire Corporation of Canada, Ltd., Toronto, has been incorporated with a capital stock of $3,000,000 by James E. Knox, 53 College Street; Frederick J. Livingston, 241 Jarvis Street; Edmund Barber, and others to manufacture automobile tires, accessories, etc.

The Canadian Sander Mfg. Co., Ltd,. Brockville, Ont., has been incorporated with a capital stock of $20,000 by Arthur C. Jones, Ray, L. Carter, both of Syracuse, N. Y.; John H. Craig, Solvay, N. Y., and others to manufacture machinery, engines, boilers. etc.

Mustikon, Ltd., Toronto, has been incorporated with a capital stock of $250,000 by William A. J. Case, Room 801, Dominion Bank Building; James B. Taylor, Belhaven Road, George E. Atwood and others, all of Toronto, to manufacture automobiles, accessories, etc.

The Connaught Motor Sales Co., Ltd., Hamilton, Ont., has been incorporated with a capital stock of $60,000 by William E. Angold, Harry J. Jarman, John R. Marshall and others to manufacture and repair automobiles, motors, engines, etc.

The Eureka Pattern & Mfg. Co., Ltd., Toronto, has been incorporated with a capital stock of $40,000 by David B. Adamson, Thomas Bathgate, 115 Marchmont Road; William Owen and others to manufacture patterns of wood and metal, castings, machinery, etc.

The Mead Universal Co., Ltd., Toronto, has been incorparated with a capital stock of $350,000 by George A. Young, Room 303, 12 King Street East; Joseph E. Hallat, Norman C. Urquhart, 1387 Queen Street West, and others, to manufacture and repair automobiles, engines, motors, etc.

In the first half of 1919 Ontario mines produced 70,955 tons of iron ore, of which 65,151 tons went to Ontario blast furnaces, and 5,804 tons was shipped out of the Province. Foreign ore smelted in the period was 598,591 tons. Pig iron output was 303,577 tons, steel 296,081 tons, and spiegel 23,955 tons.

That a small percentage of copper in basic open-hearth steel tends to prevent corrosion was shown by D. M. Buck in a paper entitled "The Influence of Very Low Percentages of Copper in Retarding the Corrosion of Steel," presented at the Atlantic City meeting of the American Society for Testing Materials. Copper to the extent of 0.12 per cent is said to be sufficient to neutralize the influence of 0.055 per cent sulphur. Even if the sulphur is much higher than normal, copper to the amount of 0.15 per cent is sufficient to protect the steel from corrosion.

GROWTH OF CANADIAN MERCANTILE MARINE.

Vickers Launch Another Vessel.

On August 16th, the S.S. "Canadian Miller" was released from her building berth and launched into the fitting-out basin at Canadian Vickers yard. The launch was successfully performed by Mrs. J. W. Norcross. There was no reception but the ceremony was witnessed by a few guests, representatives of the press and the company's directors and officials.

The dimensions of the "Canadian Miller" are:—

Length, between perpendiculars.. ..	400 feet
Breadth, moulded	52 feet
Depth, moulded..	31 feet
Draft, moulded	25 feet

She will have a deadweight cargo carrying capacity of approximately 8,500 tons and speed of over 11 knots.

After the launch she was towed to the fitting-out basin where her engines and boilers will be installed, her smoke stack, masts, and derricks placed in position, and her internal fittings completed. The present arrangements will ensure the vessel being ready for sea about September 15. Everything entering into the construction of this ship, with the exception of the steel plate, anchors and chains, have been fabricated in Canada. The berth at the filling-out wall to which this vessel was towed was occupied but two days previously by her sister ship, the S.S. "Canadian Seigneur," which successfully ran her trials during the week, and was at once sent up harbor to load cargo for her maiden voyage. The "Canadian Miller" will be the fifth vessel from Canadian Vickers yards, bringing the total dead weight cargo tonnage, delivered by this company to the Canadian Government, up to approximately 40,000 tons, and three more vessels are at present under construction. Of the ships already delivered to the Canadian mercantile marine a recent one is the "Canadian Ranger," which arrived in Montreal on July 31st, after her first voyage to England and proceeded to sea on her second voyage exactly one week later. The other vessels are the "Canadian Voyageur" and the "Canadian Pioneer," both of these having been in commission since the early part of the year carrying Canada's exports to other countries. Records such as these, to say nothing of the construction coming from other shipyards in the Dominion, fully justify the vigorous policy of the present Minister of Marine, the Hon. C. C. Ballantyne. In watching this splendid ship move from her berth into the water one recalls the statement made by many British ministers in replying to "What has made Britain so great," and on every occasion the main reason given is that it is Britain's tremendous mercantile marine which of itself brings a vast volume of trade to the country. Canada has practically unlimited natural resources and is spending vast sums of money to develop them, but all her efforts in this direction are limited by the fact that to-day she only owns a very small percentage of the shipping using her ports. Britain has become great largely by her possession of shipping and Canada's true line of national development is in the same direction.

Thanks to the realization of these points by the Hon. C. C. Ballantyne, Minister of Marine and Fisheries, Canada is now embarking on an extensive national shipbuilding programme with which she is determined to get the control of her own overseas trade. This is her true national policy and she is quite able to carry it out successfully because to-day she can build ships equal in quality with those of any country in the world.

INDUSTRIAL CO-OPERATION AND PROFIT-SHARING.

Dominion Sheet Metal Corporation Sells Stock to Employees.

One firm which appears to be succeeding in bringing about a spirit of friendly co-operation amongst its employees is the Dominion Sheet Metal Corporation, Hamilton. This concern is but of recent origin, having commenced operations in 1915, but the management was quick to see the necessity of action on its part to establish and maintain harmonious relations with the workers. A start was made in 1916, by granting a 5 per cent bonus to all who were in the employ of the company on the 20th of December. Other progressive measures soon followed. In 1917 the five per cent bonus was continued, and, in addition, a yearly bonus was given to the staff. A "Benefit Club" was also formed. In 1918 a ten per cent bonus was granted to all; yearly bonus to the staff; Benefit Club work enlarged; Garden Club formed; tonnage bonus to shop force. 1919—Staff bonus, tonnage bonus, yearly per cent will be paid; Benefit Club continuing and enlarging operations; stock offered to employees on very generous terms; vacations for all with time paid by the company.

The purposes of the "Benefit Club" are "social and beneficial." Its operations are not hemmed in by any hard and fast set of rules, and there are very many ways of looking after a man's welfare besides granting him a certain limited amount when he is sick. The Club is ready to lend a helping hand when needed, and on occasions such as weddings and births it has done its part in adding to the happiness of the event. At times, too, it has made possible a decent burial, where otherwise the circumstances would have been difficult.

Operation of Benefit Club.

"All the employees put in fifty cents a month each in the Benefit Club," states Mr. Enlow, president of the company. "In fact it is no use having a benefit club if the men do not put some of their own money in. The company's share in the work comes from putting in the bonuses of the men who quit before the year is up. We simply take the yearly pay roll. We know what the total on that should be for bonuses, and we know what we have paid out. The difference goes to the Benefit Club. In 1917, we put in $780 and in 1918, $1,800. In this way the company does not gain in any way by an employee leaving."

Tonnage Bonus.

The nominal capacity of the galvanizing plant is thirty tons per machine per day, but by close work this can be increased by a fair margin. To encourage this increased production, early in 1918 a bonus was planned for the men engaged in the galvanizing operations. This worked satisfactorily, but was not broad enough. The galvanizing is the main part of the work in the shop, but all the men cannot be engaged in that particular operation, though all can hinder or help the output, and so the bonus was made applicable to the whole shop. As soon as the 30-ton output for the day has been reached, one cent an hour is paid for each additional ton.

Depending on efficiency and service, there is a bonus paid to the staff. The company is now starting to pay this bonus quarterly and find the men like it better than yearly.

This year all the employees are getting a week's holidays with full pay. The holiday idea was first started some years ago when the company bought a piece of land in the best hunting ground in Northern Ontario, and set up a cabin in the woods. The superintendent was asked to keep an eye out during the season for the men in the plant who were doing good work, and in the fall a list was made out, and a dozen of the men were told to quit work and get ready. The company staked them to the grub pile, a chef, dogs, guide, guns and ammunition.

Company Offers Stock to Employers.

Another method by which the company is seeking to get the good will and co-operation of the employees is by offering them stock on very favorable terms. The employee is guaranteed eight per cent and during the period while he is paying for the preferred stock he is credited with an amount corresponding to the annual rate of dividend paid on the same number of common shares of the corporation's stock. Below is a copy of the application for the preferred stock of the company. The blanks have been filled in as though the amount was five shares:

"To Employees of Dominion Sheet Metal Corporation, Limited.

Kindly note conditions of this issue and signify your consent to same by signing this agreement in duplicate, retaining one copy.

Your allotment is 5 shares.

The certificates will be dated June 1st, 1919, and carry regular 2 per cent quarterly dividends from that date.

You agree to pay $10.00 each month (beginning June, 1919, which payment is to be applied against total of $500.00 in purchase thereof.

In addition dividends of 2 per cent will be credited as declared and paid by Dominion Sheet Metal Corporation, Ltd. No interest will be charged on unpaid balances under this agreement.

At the close of our fiscal years, November 30th, 1919 and 1920, you will receive credit to correspond to the annual rate of dividend paid on the same number of common shares of the Corporation's stock, and quarterly during 1921 at the quarterly rate paid on Corporation's Common Stock until final payment is made.

When final payment is made the stock will be delivered to you by Dominion Sheet Metal Corporation, Ltd., and thenceforth will carry regular quarterly dividends as paid on Corporation's Preferred Stock.

Prior to final payment, or on termination of your employment before final payment, you shall be entitled to transfer your interest to any other employee who will agree to pay balance on original terms, and who shall receive the same dividends and credits, or to sell stock to anyone not an employee provided said purchaser pays balance due to Dominion Sheet Metal Corporation in one payment forthwith, and who shall thereafter receive regular dividends as declared and paid on preferred stock.

It is agreed that Dominion Sheet Metal Corporation, Ltd., shall retain stock in their keeping until final payment.—"From Contract Record."

The Union Cap Screw Co., Ltd., with capital stock of $100,000 and head office at Walkerville, Ontario, is incorporated for the manufacture of screws, screw machines and associated products. Parties incorporating are Charles A. Whitman and others of Detroit, and James G. Bass of Windsor, Ont.

The Use of Benzol and Benzol Mixtures as Motor Fuel

(By I. C. Mackie.)

The recovery of crude benzol or light oil from coal gas was greatly extended and developed during the war, primarily for the sake of the toluol so obtained. The crude light oil consists of approximately 72% benzol, 20% toluol, and 8% solvent naphtha which latter is largely Xylol. The demand for toluol for explosive manufacture was always greater than the the supply, but the other two constituents of light oil were produced in excess of the requirements for strictly war purposes and other uses had to be developed.

For several years benzol and solvent naphtha, produced in the D. I. & S. Co. plant, have been used as motor fuel by a steadily increasing number of automobile drivers in this district. Of course, benzol products were used for this purpose long before the war in France, England and other European countries, but little was known here of the practice, and, for the general public, the fuel was new. The first users were steel company officials who obtained very gratifying results. Others soon followed and the demand has steadily increased. As was to be expected with any new thing some individuals were dissatisfied and had all sorts of complaints against the benzol. For a time there seemed to be a tendency among the garage repair men to attribute all kinds of car trouble to the use of benzol. If a driver had run his engine—short of lubricating oil or without water in the radiator and had badly overheated his engine and had at the same time been using benzol fuel this was a demonstration that benzol given "too hot a flame, warps the valves and burns the engine up." The benzol was a mysterious unknown factor and was a convenient goat for all kinds of trouble. In spite of such difficulties, the superior qualities of benzol motor fuel have steadily enlarged the number of more than satisfied consumers.

Of all the criticisms made regarding the use of benzol in automobiles, only two need be considered.

First.—It is said that benzol dissolves the protective coating from the cork float in the carburetor, causing it to lose its buoyancy and allow flooding, This is said to have been more frequent with Ford cars than with other makes. The usual coating material on the cork float is shellac, which is very slowly and very slightly soluble in benzol. Many drivers have used benzol for two or three years, without the slightest trouble of this kind. It is possible that various protective coatings may be used on different cars. In any case the deterioration of the float's buoyancy seems very slow and a simple remedy is to dry out the float and recoat with shellac. A hollow metal float may be used if desired, while a coating of celluloid varnish is also recommended. The number of cases of trouble from this source is not large. Personally the writer is using benzol products during the third season on the same cork float without a suggestion of trouble.

Second.—The statement was commonly made and at first everywhere accepted that in using benzol it was necessary to make the mixture leaner. More air had to be taken in at the carburetor than for gasoline. After some reflection it was decided to test this point. From a theoretical standpoint it was difficult to confirm this statement.

The benzol molecule is less complex than the average molecule of a gasoline mixture and requires less air for the same volume of vapor. For equal weights of benzol and gasoline also the gasoline requires the greater quantity of air owing to its higher percentage of hydrogen. Only in the case of equal volumes of the two liquids, would benzol by reason of its greater specific gravity, require slightly more air for complete combustion.

Just what the action of a carburetor and engine would be could only be determined by trial. The method employed to ascertain the degree of combustion was to sample and analyze the exhaust gas from the engine while using the different fuels. It would take too much time to give details of each test. All have pointed to the same conclusion and only a few typical exhaust analyses will be given. These tests were made on a model 90 Overland car with Tillotson carburetor. Samples have been taken with the engine runing light and also while driving on the level and climbing hills. The nature of the exhaust gas is not affected by these varying conditions but is determined by the speed with which the engine is turning over. For low speed a proper setting, the mixture tends to be leaner with considerable surplus air, and as the engine is speeded up the free oxygen in the exhaust drops to one or two per cent. with the appearance of a small amount of carbon monoxide.

Table 1 shows the effect of various settings of the carburetor needle valve and also the effect of the surrounding temperature both for gasoline and benzol products, all tests being made at the same engine speed, equivalent to about 17 miles per hour.

TABLE I.

Place and Temperature. °F.	Cold Air Inlet. Open.	Needle Valve Opened. Degs.	Disco Fuel, 72% benzol, 21% toluol, 7% naphtha.			Gasoline.		
			CO_2	O	CO	CO_2	O	CO
Garage, 65-70	¾	290	14.9	1.7	0.6	12.8	0.8	1.4
Garage, 65-70	"	360	12.8	1.2	4.4	9.9	1.0	6.3
Garage, 65-70	"	450	8.4	1.1	11.8	6.5	1.2	11.6
Garage, 65-70	"	540	7.5	2.2	13.3	6.4	1.0	11.7
Outdoors, 25	"	240	10.7	6.8	nil	11.8	3.4	nil
Outdoors, 25	"	360	13.2	2.5	2.5	10.4	2.3	3.5
Outdoors, 25	"	450	9.2	2.0	9.5	7.7	2.0	8.5
Outdoors, 25	"	540	7.7	2.0	11.8	6.5	2.3	10.3

You will observe that the benzol gives an exhaust higher in CO_2, higher in free oxygen and lower in CO, for all ordinary carburetor settings. In the case of the needle valve being open 540 degrees, a very much too rich setting, the carbon monoxide is higher in the benzol exhaust.

This is for the same reason that a proper setting gives a higher CO_2 with benzol, namely that the composition of benzol shows a higher ratio of carbon to hydrogen than does gasoline. Consequently when the combustion is almost complete the CO, content of the exhaust will be higher for benzol and conversely when the air is insufficient and the fuel is burnt largely to carbon monoxide, the benzol will give a larger percentage of this gas than will gasoline.

Note the different setting required depending on the surrounding temperature of the air.

Table II shows the effect of various adjustments

of the cold air inlet to carburetor, leaving the needle valve unaltered. These tests were made in a heated garage and at an engine speed approximately equal to 17 miles per hour.

TABLE II.

Additional Tests of Exhaust Gas from Motor Car Engine Made in Heated Garage, Jan. 28, 1919.

(All tests except the last at engine speed giving 10 ampere charge to battery. Disco Fuel used.)

Carburetor Adjustment Cold Air Ring.	Needle Valve Open.	Exhaust Gas CO_2	O	CO
¾ Open	360°	10.6	2.2	6.9
Closed	360°	7.2	3.8	10.6
Full Open	360°	12.5	2.8	3.6
¾ Open	290°	14.1	3.1	0.9
¾ Open	360°	4.3	15.3	0.4?

(Closed throttle, minimum speed on this test.)

Although the foregoing tests and others not reported had indicated that no alteration of carburetor was necessary when changing from gasoline to benzol mixtures, it was decided to make a test, as to whether benzol, under extreme conditions might require more liberal air supply than gasoline.

For this purpose the garage was heated to 110 deg. or higher by means of a gas furnace, and the cold air inlet to carburetor was entirely closed. The air drawn in was thus taken at 110 degrees and still further heated in contact with the exhaust manifold. With these conditions the needle valve was set to give a normal exhaust with gasoline. Without altering the setting, the gasoline was replaced with C. P. Benzol, the most volatile member of the benzol series, and which might be expected, at the high temperature employed, to give a mixture showing a deficiency of air. Table III shows the results.

TABLE III.

In garage at 110°F. Cold Air Inlet to carburetor closed. Engine speed as for 17 miles per hour.

Analysis of Exhaust.

Fuel—C. P. Benzol. CO_2	O	CO	Fuel—Gasoline. CO_2	O	CO
			11.3	2.4	2.2
14.2	2.7	1.0	10.6	1.7	4.2

Even under such extreme conditions the combustion is more nearly complete with the benzol.

Table IV shows the effect on the mixture of a variation in the engine speed.

TABLE IV.

Analysis of Exhaust Gas.

Engine Conditions:	Fuel, 60% Benzol, 40% Xylol. CO_2	O	CO	Fuel, Gasoline. CO_2	O	CO	Fuel, 75% Gasoline, 25% Disco Fuel. CO_2	O	CO
Engine speed approx. as for 20 miles per hour driving	13.5	2.8	1.0	11.1	2.7	2.2	...	...	...
Slow speed. Closed throttle	8.8	9.6	...	6.3	11.5	nil	...	...	...
Carburetor re-adjusted, but practically the same as before. Engine speed approx. as for 20m. per hr. driving.	...	...	...	10.6	2.8	2.8	11.0	2.8	2.7
Slow speed. Closed throttle	...	...	...	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table V shows exhaust gas taken from a car under actual driving conditions, on the level and climbing a hill. The speed varied between 13 and 17 miles per hour. The exhaust shows no change in composition from that with the engine running light at the same speed.

TABLE V.

Exhaust Gas Samples.

Fuel used:	On the level. CO_2	O	CO	Climbing hill. CO_2	O	CO
Gasoline	10.4	2.1	3.8	11.4	1.4	2.8
Gasoline	9.6	2.2	4.2	Sample lost.		
Disco Fuel	13.6	2.3	2.0	13.2	4.0	Lost
Disco Fuel	13.6	3.3	nil	Sample lost.		
75-25 Mixture	11.1	4.9	.5	12.5	2.8	[illegible]
75-25 Mixture	11.6	2.7	1.6	Sample lost.		

The exhaust gas composition, under a great variety of conditions, surely indicates that a carburetor setting that is satisfactory for gasoline, needs an adjustment when changing to benzol fuel. This conclusion is entirely confirmed by the experience of many drivers who regularly use the same setting for both fuels with entire satisfaction and freedom from carbon trouble over a full season of long mileage.

There is one point on which no direct evidence has yet been obtained, and for which it is rather difficult to devise a satisfactory trial or experiment. It is this: Given a carburetor setting too rich for gasoline, and under which the engine is steadily accumulating a carbon deposit, would the rate of carbonizing be increased by changing to a benzol fuel? It seems quite possible that such is the case, owing to the higher percentage of carbon in benzol. If this proves to be true it would help to explain the origin of the opinion that benzol requires more air in the carburetor adjustment. The tendency with the less careful or less intelligent driver is to carry a mixture that is too rich and which ultimately causes carbon trouble with gasoline. Possible such a driver would have his trouble earlier by changing to benzol. This is a mere assumption however and remains to be tested.

Benzol shows a marked superiority over gasoline both as regards the power developed by the engine and the mileage obtained per gallon. No definite figures have been obtained locally as to the relative power of the two fuels but the difference is so pronounced that it needs no demonstration to one who has driven the same car on the two fuels. Hills are easily negotiated on high gear with benzol that would be difficult or impossible with gasoline.

As to the relative mileage obtained a good comparative test was made recently at the local half-mile trotting park.

The car used was a model 90 Overland with four passengers. Total weight 3175 lbs. The fuel was fed into the carburetor from a graduated glass cylinder so that the amount consumed for each lap could be read off in cubic centimeters. The consumption was very uniform lap after lap showing the conditions to be remaining constant. Twenty laps were driven with gasoline and then twenty with Disco Fuel, no alteration being made in the carburetor. The results calculated to miles per gallon were as follows:

	Miles Per Gallon.
Gasoline	22.98
Disco Fuel	30.09

31% greater mileage for the benzol.

These figures are borne out by the experience of all drivers.

There is one interesting point with regard to the behavior of benzol fuel. The spark lever can be left in the most advanced position, at all times, even when the engine is laboring at slow speed, without any sign of a knock developing. With gasoline on the other hand the spark must regularly be retarded with reduced engine speed, especially if under much load, to avoid a pronounced knock due to premature explosion. It would seem that the combustion of the benzol vapor is not so sudden as that of the gasoline. The difference with regard to spark control is very pronounced and connot fail to attract the notice of a driver using benzol for the first time. It makes driving easier in eliminating any necessity of spark adjustment.

The one advantage of benzol products, in their normal proportions as recovered from the gas, is the comparatively high freezing point.

Disco Fuel (72% benzol, 21% toluol and 7% naphtha) freezes at 10 degrees F. Of course it is possible to blend the three in other proportions to make a perfectly satisfactory motor fuel and of as low a freezing point as desired, but this would necessitate selling one mixture in the summer and another in the winter, which would be undesirable. The best solution seems to be to blend benzol products with enough gasoline to give a safe all the year round fuel. A 50-50 mixture has a freezing point of about -30 F. which would be satisfactory. Such a mixture is much superior to gasoline in power and mileage obtained. Of course, those who are able to obtain a larger proportion of toluol or Xylol to depress the freezing point would not willingly accept any gasoline in their fuel if possible to avoid it.

Table VI gives some of the more important freezing points.

TABLE VI.

			Freezing Point. °F.
C. P. Benzol			41
C. P. Toluol			-134
C. P. Xylol			— 67
Mixtures			
Benzol	+	Xylol	
95	+	5	36
90	+	10	33
85	+	15	29
80	+	20	23
75	+	25	17
70	+	30	12
65	+	35	7
60	+	40	1
55	+	45	4
50	+	50	—10
Benzol	+	Toluol	
65	+	35	1
Benzol	+	Gasoline.	
60	+	40	13
50	+	50	4
40	+	60	— 4
35	+	65	—10
30	+	70	—17
25	+	75	below —25

71% Benzol, 22% Toluol 7% Naphtha 10.

Mixtures.			
Disco.		Gasoline	
50	+	50	—29
25	+	75	Probably below —50.

STEEL WAGES AND PRODUCTION.

Their Opposite Paths.

N. Y.—During the past few years, or since the beginning of the war, steel wages have advanced an average of about 170%. In the same period efficiency of the steel worker has decreased an average of probably 20%, as indicated by the figures of number of workers employed and annual production given in the reports of the large steel companies.

Actual labor costs, consequently, have advanced something like 225% on average ton produced.

In the decade preceding the war steel reports showed a gradual increase in the tonnage production per man. chiefly due to the installation of labor-saving machinery. Since 1915, however, tonnage output per man has fallen off steadily. In 1918 average production of finished steel per man employed by United States Steel Corporation was only 52 tons, against 56 tons in 1917, 61 in 1916 and 62 in 1915.

Wage per ton of output advanced from $15.03 in 1915 to $32.68 in 1918. As average yearly pay of Steel Corporation's employees in December last was $1,950., compared to a general average of $1,685 for the whole year 1918, it is almost certain that the ton wage to-day is considerably higher than the $32.68 average for last year.

Similar conditions are shown in the case of Republic Iron and Steel which had an annual output per man employed of 93 tons in 1915, reduced to 70 tons in 1918. Republic's average wage per ton increased from $8.30 in 1915 to $23.20 in 1918.

Apparent discrepancy between the tonnage labor costs of United States Steel and Republic is explained by the large number of more highly finished products made by the Steel Corporation and the large number of men it employs on its railroads and other lines not directly connected with steel manufacture.

Following gives the wages paid, number of employees, tons of finished steel shipped, average wage per man and wage per ton each year by United States Steel since organization:—

Year	Wages paid.	No. of employees	Fin. steel shipped	Av. wage per man	Wage per ton
1918	$452,663,524	268,710	13,849,483	†$1,685	$32.68
1917	347,370,400	268,058	14,942,911	1,296	23.24
1916	263,385,502	252,668	15,460,792	1,042	17.08
1915	176,800,864	191,126	11,762,639	925	15.03
1914	162,379,907	170,353	9,014,512	905	18.01
1913	207,206,176	228,906	12,374,838	905	16.74
1912	189,351,602	221,025	12,506,619	857	15.14
1911	161,419,031	196,888	9,476,248	820	17.03
1910	174,955,130	218,435	10,733,995	801	16.20
1909	151,663,394	195,500	9,859,660	776	15.37
1908	120,510,829	165,211	6,206,932	729	19.41
1907	160,825,822	210,180	10,564,537	765	15.22
1906	147,765,540	202,457	10,578,433	730	13.96
1905	128,052,955	180,158	9,226,386	711	13.89
1904	99,778,276	147,343	6,792,780	677	14.68
1903	120,763,896	167,700	7,458,879	720	16.19
1902	120,528,343	168,127	8,197,232	717	14.70
1901	*90,000,000	....	7,426,480	....	*12.11

Following is Republic Steel's record over the past four years:

Year	Wages paid	No. of employees	Fin. tons produced	Av. wage per man	Wage per ton
1918	$23,747,260	14,668	1,024,000	$1,619	$23.20
1917	17,574,480	14,150	1,109,829	1,211	15.82
1916	12,778,836	13,056	1,216,716	979	10.49
1915	8,558,574	11,105	1,033,400	771	8.30

Figures for these two companies may be accepted as representative of the situation with regard to the trade as a whole. They bear out the claim of steel manufacturers that labor efficiency has been gradually lessening in recent years, a situation which labor shows no disposition to correct, although it is beyond question that increased production is the foremost need of the world to-day.—Boston News Bureau.

* Approximated.

† The average in December, 1918, was $1,950. The average salary or wage per employee per day in 1918, exclusive of general and administrative force, was $5.33, compared with $4.10 in 1917. Including general administration and selling force, $5.38 a day, compared with $4.16 in 1917.

CANADIAN ENGINEERING STANDARDS ASSOCIATION.

The Secretary of the Canadian Engineering Standards Association announces that a stock of a number of the most important publications of the British Engineering Standards Association has now been received, and can be obtained on application. The following list does not include all publications of the British Engineering Standards Association, but covers those of recent issue which have been published under the new regulations. Copies are for sale at the prices stated.

B. E. S. A. PUBLICATIONS.

Report No. C L 3750.—**Interim Memorandum on French Metric Screw Threads for Aircraft Purposes** . . . . 15c net

This memorandum describes the system of screw threads for aircraft purposes used by the French Military authorities and is accompanied by tables showing limits of size, tolerances, etc., for two grades of fit. The form of thread is that of the Systeme International, in which the crest is sylindrical while the root of the thread is curved in section. The fiver tolerances are provided for cases where great accuracy is required. The second grade tolerances are suitable for ordinary bolts and nuts.

Report No. 10-1904. Revised July, 1918.—**British Standard Tables of Pipe Flanges** . . . . 25c net

This report gives the British Standard dimensions for pipe flanges for steam and water piping for low pressures and high pressures, dimensions of welded-on flanges for pipe lines for working steam pressures of 125, 225, and 325 lbs. per square inch, dimensions for short flanged bends and tees of castmetal for pressures up to 325 lbs. per square inch, and dimensions for long bends of wrought iron and steel.

Report No. 15-1912. Revised August 1912.—**British Standard Specification for Structural Steel for Bridges, etc., and General Building Construction**. . . . . 25c net

This report covers process of manufacture, quality of finished steel, tensile tests, bending tests, tests on rivets, chemical analysis, inspection and other conditions.

Report No. 21-1909. Revised November 1909.—**Report on British Standard Pipe Threads for Iron or Steel Pipes and Tubes** . . . . 25c net

This report gives definitions and tables of dimensions for British Standard Pipe Threads. In this system the Whitworth form, or thread is employed, but fine pitches are used, and both parallel and conical screw ends are provided for.

Report No. 37-1919. Revised January, 1919.—**British Standard Specification for Electricity Meters** . . . . 25c net

This specification is intended to apply to the purchase of new meters, governing their sale by the manufacturer to the purchaser. Requirements for meters up to the largest sizes in use as well as for three-wire and three-phase meters are included. The electrolytic type of meter is not dealt with. The specification gives standard definitions and provisions regarding external characteristics, insulation, labels, standard method of marking, registering, mechanism minimum running current, permissible limit of error and rate of registration tests, precautions necessary in erection and other particulars.

Report No. 41-1908.—**British Standard Specification for Cast Iron Spigot and Socket Flue or Smoke Pipes** . . . . 25c net

This specification gives a schedule of dimensions and weights, with full size sections, for light cast iron spigot and socket pipes suitable for flue or smoke pipes.

Report No. 44-1909.—**British Standard Specification for Cast Iron Pipes for Hydraulic Power** . . . . 25c net

Provision is made for two classes of this pipe together with bends, tees and special castings.

Class A:—Working pressures from 700 to 900 lbs. per square inch.

Class B:—Working pressures from 900 to 1,200 lbs per square inch.

The specification covers quality of material permissible variation of weight, marking, testing, inspection and tables of dimensions and weights.

Report No. 45-1917. Revised September 1917.—**Report on British Standard Dimensions for Sparking Plugs for Internal Combustion Engines** . . . . 25c net

This report covers external dimensions only, the form of thread used being a metric thread having a 60 degree angle. Tolerances on full diameter, effective diameter and core diameter for the thread on the plug and in the tapped hole are given, together with external dimensions of the complete plug, and standard nomenclature of sparking plug parts.

Report No. 46-1909.—**British Standard Specification for Keys and Keyways** . . . . 25c net

The specification covers material tests, definitions and tables dimensions for three classes of key: (a) Parallel Sunk Key, (b) Taper Key, (c) Taper Sunk Key.

Report No. 63-1913.—**British Standard Specification for Sizes of Broken Stone and Chippings** . . . . 25c net

This specification was formulated as a result of conferences between the quarry owners and road authorities and gives standard nomenclature, definitions and methods of measurement for broken stone and chippings.

Report No. 65-1914.—**British Standard Specification for Salt-Glazed Ware Pipes** . . . . 25c net

This report contains tables of dimensions and particulars regarding sockets, grooving, glazing, permissible variation in thickness and diameter, methods of testing for strength and absorption.

Report No. 71-1917.—**Report on British Standard Dimensions of Wheel Rims and Tyre Bands for Solid Rubber Tyres for Automobiles** . . . . 25c net

This report gives standard sizes of wheel rims and corresponding internal dimensions of solid rubber tires, for sizes of wheel varying from 670 mm. to 881 mm. Metric dimensions are used throughout.

Report No. 72-1917. Revised September 1917.—**British Standard Rules for Electrical Machinery.** (Excluding motors for traction purposes). . . . . 25c net

This important report is intended to define the conditions which characterize British standard electrical machinery, including transformers but excluding traction motors and to provide the purchaser and manufacturer with a general specification indicating the information which should be forwarded with an enquiry or an order for an electrical machine. Methods of defining the rating or rated output are formulated, and in this connection are in substantial agreement with the corresponding rules of the American Institute of Electrical Engineers. Enquiries based on these rules will enable the purchaser to compare tenders received from various manufacturers.

Report No. 74-1917. Revised September 1917.—**British Standard Specification for Charging Plug and Socket for Vehicles Propelled by Electric Secondary Batteries** 25c net

This report contains the provisions necessary to secure interchangeability between any charging plug and any socket of the concentric type. Dimensions of the contact portion of the plug and socket, and dimensions of the guage needed to check these are given.

Report No. 75-1916—**British Standard Specification for Wrought Steel for Automobiles** . . . . 25c net

This important report contains definitions of terms used, methods of testing, and specifications for ten

grades of carbon, nickel, and nickel-chrome steel, each specification giving chemical composition, tensile and brinell tests.

Report No. 76-1916.—**British Standard Nomenclature of Tars, Patches, Bitumens and Asphalts When Used for Road Purposes and British Standard Specification for Tar and Pitch for Road Purposes** .. .. **25c net**

This valuable report defines tars, pitches, bitumens, and asphalts for road purposes, distinguishing between the tar products and bitumens and asphalts. In this respect the practice of the B. E. S. A. is not in accordance with that usual in the United States, where the term bituminous is applied in a wider sense than in Great Britain. The specification gives definitons, properties and methods of testing for two qualities of tar, and for pitch suitable for pitch-grouting.

Report No. 82-1919.—**British Standard Specification for Starters for Electric Motors.** (Face-Plate Type) .. .. **25c net**

This report covers definitions, pressures, methods of enclosure, standard sizes and ratings, general construction, marking and tests.

Report No. 84-1918.—**Report on British Standard Fine (B. S. F.) Screw Threads and Their Tolerance** .. .. **25c net**

This report gives revised tables of dimensions for British standard fine screw threads and covers theoretical dimensions and standard sizes and tolerances of bolts and nuts for two grades of fit. The report also contains an appendix dealing with methods of determining and compensating for errors in pitch, form of thread and diameter. Much information is given regarding methods of guaging screw threads.

Report No. 88-1919.—**British Standard Specification for Electric Cut-Outs for Low Pressure, Type O.** .. .. **25c net**

This specification covers dimensions and standard sizes of cut-outs for low pressure and ordinary duty. A separate specification is contemplated for heavy duty cut-outs.

Requests for copies of any of the above should be addressed to:—

THE SECRETARY,
Canadian Engineering Standards Association,
Room 112, West Block, Ottawa.

and should be accompanied by money order payable to the:
Canadian Engineering Standards Association.
Ottawa.

THE ENCOURAGEMENT OF SCIENTIFIC RESEARCH

The latest epidemic of influenza has caused men to search for strange specifics and remedies of other times unthought of. There have appeared in the press many proposals as to how the spread of the disease should be hindered, and, finally, a suggestion that a power to whose nature the public at other times shows a somewhat marked indifference, research, should be called in to determine the nature of the malady and a sure cure. None of the papers that we have chanced to see gave its readers any idea as to the nature of the research which it demanded, or as to what body or individuals were to undertake it, or who would pay for it. For them, apparently, research was a kind of quinine, a substance of complicated and uninteresting structure for which, in the ordinary way, the Englishman had no need, but of which there must be a store lying about somewhere, to be drawn on in cases of emergency.

There is, however, a great danger in this way of looking at things. If scientific research—that is, a critical study of natural processes undertaken to obtain deeper insight into the principles which govern them—is to be regarded merely as a method of obtaining results which may alleviate the disease of the moment, or may cheapen or facilitate some manufacturing process—if the immediate achievement of some such end is to be made the criterion by which researches are to be valued and encouraged, then by far the greater and more valuable class of researches will be left to look after itself, which it is ill able to do. There should be some realization of the double importance of researches undertaken by scientists of ability in order to extend the bounds of knowledge, and not to gain information of demonstrated and obvious practical value. The desirability of knowledge for its own sake is a cardinal principle with most educated men (but not, alas! with such people as Cabinet Ministers and popular journalists; men who hold Edison for a model of what a scientist should be), and on this ground alone, investigations in pure science are worthy of support, but they have a more direct and material claim. It is the knowledge won in the laboratory and study by the student of natural philosophy (to use the dignified old term for pure science) that the inventor and technical scientist applies in his work; all electrical machines and devices are based on principles won in pursuit of no practical end, and it is to the discovery of fresh principles that advances in applied science are ultimately to be traced. These things are best made clear in an example, and the evolution of wireless telegraphy furnishes an excellent illustration of the way in which inquiry, philosophic rather than practical in its spirit, leads to results of the greatest material use to humanity.

The first link of the chain of thought which had to wireless telegraphy may be said to have been a purely philosophical difficulty felt by Faraday. When two electrically-charged bodies are suspended in a vacuum—that is, with no material substance between them—they attract (or repel) one another. How is the force conveyed from one body to the other? Many older physicists, or, as Faraday would have preferred to have called them, natural philosophers, found no difficulty in the conception of action at a distance: they were as content to take it as a fact as the gunner is to accept the propulsion of his shell by the cordite without inquiring as to the exact mechanism of explosion. In the matter of gravity, however, Newton had already found a difficulty in admitting that it should act across empty space without anything to carry the force; in his own words, "that a body may act upon another at a distance through a vacuum and without the mediation of anything else, by and through which this action and force may be conveyed from one to another, is to me so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking, can ever fall into it. Gravity must be caused by an agent acting constantly, according to certain laws, but whether this agent be material or immaterial, I have left to the consideration of my readers." This passage was familiar to Faraday, and the idea of action at a distance between electrified bodies vexed him in a similar way. To enable him to reason about the laws of this action, and plan fresh experimental investigations to elucidate these laws, he had to invent a mechanism which should give him a clear mental picture of what was happening. He imagined that surrounding the bodies was an immaterial medium, the ether, which was set in a state of strain by the electrified state of the bodies; between them in this ether stretched 'tubes of force,' which were in a state of tension and, tending to shorten, tried to bring the bodies together. All electrical phenomena involving an action across a space ordinarily called empty he completed in his mind in terms of this ether and the stresses set up in it. Thus, consider the case of an electrical condenser—that is, two parallel plates of metal not connected by any conductor. When this is charged a certain amount of electricity runs into

one plate and out of the other, but the current cannot flow from one plate to the other, so that, on the older theories, the circuit was incomplete. Faraday imagined that the ether between the plates was put into a state of strain, the setting up of this strain being a 'displacement current' in the ether. When the condenser is discharged, the ether returns to its unstrained state. The straining of the ether can be considered analogous to the extending and holding fast of a spring; when the spring is released it shortens, and gives up its energy, just as when the condenser is discharged it gives up its electrical energy. But it is well known that when a spring is released it swings backward and forward in prolonged vibration before it returns to its position of rest . How does the condenser behave in this respect? Experiment has shown that the analogy holds; in general the electricity swings from one plate to the other, at any instant one plate being positively charged, and the other negatively, the state of each plate alternating. An electrical oscillation is set up; the whole discharge occupies only a fraction of a second, so that the detection of the oscillation is a matter of refined experiment, but it has been established beyond all doubt.

Faraday's theory was taken up by another man who devoted his life to pure science, James Clerk Maxwell, who gave to it a definite mathematical form. He followed to their logical conclusions equations expressing Faraday's assumptions, and showed that if indeed the ether carried stresses of the kind imagined by Faraday, then it must be able to convey waves of electric and magnetic force, just as an ordinary solid conveys sound-waves. A general idea (which must not be pressed too far) of the process can be obtained by considering the ether as an elastic substance, like a block of india rubber, filling all space If charging two near bodies does indeed set up a strain in this ether, then the sudden release of this strain must set the ether between the bodies vibrating like a released spring, and this vibration will spread out in all directions from the neighborhood of the bodies through the elastic medium just as a ripple spreads from the disturbance caused by dropping a stone into a pond. Clerk Maxwell was able to calculate what would the velocity of such an electro-magnetic wave in space, and found a value approximately the known velocity of light. Light had long been supposed to be a vibration of the ether, this medium being assumed in order to provide a seat for the energy of light vibrations on their way hither from the sun. Hence, Maxwell supposed that light was of the nature of an electric disturbance (or rather an electro-magnetic disturbance, since Faraday had shown that a change of electric force was always accompanied by a change of a magnetic force, and **vice versa**), a supposition known as the electro-magnetic theory of light. An actual propagation of an electric disturbance from a discharge of electrified bodies had, however, so far never been demonstrated.

The next link in the chain was provided by Heinrich Hertz. A disciple of Maxwell, he set himself to produce an experimental confirmation of his theory. The discharge of strongly electrified bodies, such as on Maxwell's theory should lead to electric waves, is, under ordinary circumstances, accompanied by a spark. Hertz set up, in the special form known as a Hertzian oscillator, apparatus for the production of a spark, and succeeded in producing, consequent on a spark in this circuit, a spark in a second circuit, or resonator, not connected to the oscillator, and in showing that this was due to an electro-magnetic disturbance passing out from his spark. He demonstrated the wave nature of this disturbance and, further, was able to bend the path of his waves with a huge prism of pitch, just as light wave are bent by a prism of glass, and to demonstrate that in many other ways they behaved, though invisible, as light waves. In short, Hertz produced a source and a detector of electro-magnetic waves, and he succeeded in showing their passage across a large room. Wireless telegraphy within this limited space had been achieved.

It was reserved for Marconi, by devising new forms of radiator and detector, to make it possible to employ electric waves for signalling across distances large enough to give to wireless telegraphy the practical importance which it has to-day. His work showed the utmost ability and ingenuity, and it is with no desire to detract that it is emphasized that his task was merely to improve what had already been achieved in the laboratory by the labors of men who were striving to satisfy an intellectual thirst, to obtain information as to the nature of the forces displayed in electricity and light, and to confirm theories born of long trains of thought followed with no object of the kind usually called practical.

It is often put forward as an excuse for starving science and its devotees that, since such men as Faraday will be impelled to carry out their labors, however unfavorable conditions may be, it is a waste of money to reward them. Quite apart from the meanness of this attitude, and the somewhat humiliating thoughts aroused by the fact that the only material reward an English scientist is likely to receive for any great achievement is a small prize from the French Academy or a large prize from the Swedish Nobel Fund, it cannot be too often insisted that science is not advanced by the unaided efforts of a Faraday appearing once a century. Such men crystallize the scientific thought of their time, and put the labors of many into an ordered scheme; they look for support of their theories not only to their own work, but also to the experiments of many other comparatively undistinguished men who fasten upon particular points for proof or disproof. It should be recognized that, apart from the fact that to a great nation a certain encouragement of intellectual activity should be a source of pride, pure science is at the basis of all industrial research, and furnishes its motive power. It is as short-sighted a policy to encourage applied science and to neglect pure science as to devote every care to providing a ship with powerful engines and to forget to furnish her with fuel.

(The New Statesman.)

EDITORIAL

STEEL MANUFACTURE IN BRITISH COLUMBIA.

The possibility of a steel industry in British Columbia is one that has occupied the attention of publicists in that province for a considerable time. The Government itself has encouraged enquiry into the possibility, having, among other things, engaged Dr. A. Stansfield, Professor of Metallurgy at McGill University, to report on the technical aspect of the matter. Dr. Stansfield's Report has been published in 'Iron and Steel of Canada', and, while it demonstrated the feasibility of a limited extent of steel manufacture on the mainland of British Columbia, the problem as viewed by Dr. Stansfield did not offer that hope of profitable solution which is necessary to attract investors.

The desirability of having a steel plant within the provincial boundaries is obvious, but it is not convincingly apparent that this desirability extends to an absolute necessity in British Columbia's present stage industrial development.

British Columbia undoubtedly requires a great variety of manufactured steel products. She requires mining machinery in great variety, mining and high-grade steels, and also the iron and steel products required for steel shipbuilding and the manufacture of ships' engines. Then of course there will always be some demand for steel rails and general structural steel, but taken as a whole it is questionable whether the market for a sizable steel industry is present, unless an export business can be worked up.

Are the prospects for a steel export business from British Columbia encouraging? The Orient is the natural export market for British Columbia, and Asiatic Russia. Japan, however, has an established steel industry, with moderate resources of raw materials. China has one steel plant at least, with unlimited resources of coal and iron, and labor. China can only remain as an export field until that great country commences to supply herself, and then the tables will be very completely turned.

The combination needed for a successful steel industry includes, first and foremost, cheap fuel, then proximity of iron ore and good conditions for the assemblage of raw materials and the transportation of manufactured products—or, in other words, a maritime location.

Provided iron ore is available, the coast coalfield of Vancouver Island would seem to provide two of the essentials for an ordinary steel industry using coke in blast furnaces, as the Island coals are good coking coals, suitable for metallurgical uses. It may be accepted that it is better to take iron-ore to the coal-field than to bring coal and coke to the iron-ore deposit. It does not seem clear, however, that iron-ore in sufficient quantity and of required quality is proved, although most encouraging, not to say glowing reports regarding the iron-ore resources of British Columbia are received.

A blast-furnace steel industry, it is well to remember, is, except under very specialised conditions, the natural outgrowth of a coal-mining industry. This is the fundamental characteristic of the Sydney steel industry. The fuel question is probably the most important single factor in deciding the possibility of successfully making and profitably marketing steel goods. Where coal is dear and transportation difficulties have to be reckoned with, electric power assumes much importance. If it is reasonably cheap it offers the possibility of manufacturing steel near the source of the iron-ore used, and it appears likely that this combination of electric power in proximity to iron-ore deposits may be found in British Columbia.

By the use of the high-grade but refractory magnetites found in British Columbia, or by using imported pig-iron in electric furnaces operated by cheap water power, a steel industry of sufficiently large extent to meet the present requirements of British Columbia would seem to offer reasonable hopes of financial success, and there is this advantage in small units such as the electric furnace, that additions to capacity can be made as requirements justify, and the huge capital expenditure required for the blast units, with the accompanying heavy interest and amortization charges, is not called for.

Private interest will no doubt see that such initial steel-making units are installed when the opportunity offers itself, as has already been the case in the cities on the United States Pacific Coast, where electric furnace practice has made some headway.

Summarising the conclusions of this reasoning it would appear as if a steel industry in British Columbia would be the evolution of that province's industrial growth, and will probably have as its nucleus some successful foundry or machinery manufacturing establishment, much as the Nova Scotia Steel Company in Nova Scotia was the outgrowth of a successful local industry, with this difference, that the electrical unit would appear most likely to suit British Columbia conditions.

SLAG AS A CONSTITUENT OF CONCRETE MIXTURES.

In the current issue will be found a report by Mr Emmanuel Mavant detailing very fully the tests made to ascertain the comparative value of basic steel slag as a concrete aggregate in competition with materials usually employed for this purpose. It will be seen that the tests indicate that more use might be made of slag as a constituent of concrete mixtures.

Where natural and easily obtained materials for concrete mixtures and road building material are so abundant as they are in the vicinity of the existing steel works in Canada the uses to which slag can be put have not made any particular appeal, but in Europe, slag has for many years formed a useful source of revenue to steel manufacturers. In some cases the cracked and sized slag is sold for road-metal without other mixture. In other cases suitably sized slag is mixed with tar (obtained from coke-oven by-product plants) and marketed under trade names for tar macadam purposes.

Another use to which slag has been put in coal-mining districts is for packing underground wastes by the "flushing" method. The slag used for this purpose is granulated, and forms an ideal material by reason of its natural cementing properties and its great resistance to pressure.

SULPHUR IN COAL.

One of the most interesting and thought-provoking discussions which took place at the recent meeting of the A. I. M. & M. Engineers in Chicago centered around the symposium on 'Sulphur in Coal,. The matter of sulphur in coal is beginning to interest the United States' miners and steel workers because of an appreciable decline in the available quantity of low-sulphur coal. The problem is one that has attracted earlier attention in European countries and also in Canada because in these countries the quantity of really low-sulphur coal was never very great.

Dr. Reinhardt Theissen described his discovery of the presence of minute globular occurrences of pyrite in practically every specimen of coal examined by him, from anthracite to lignite, and also the presence of pyrite occurrences of identical appearance in woody peat taken from a peat bog. Dr. Theissen also demonstrated the almost universal presence of sulphur in plants, particularly in the more odoriferous plants such as mustard and onion, and he made interesting references to the probable activity of bacterial fixation of sulphur in a manner analagous to the deposition of ferric hydroxide from waters containing ferrous carbonate in solution which is ascribed to the so-called 'iron bacteria'. The main conclusion of Dr.Theissen's research was that sulphur is found in coal because it is an original constitutent of the plants that have gone to form coal. So far as the minute gobular occurrences of pyrite described by Dr. Theissen are concerned, these would therefore appear to be of primary origin, and no hope exists that sulphur in this form can be eliminated by mechanical processes such as washing.

One of the speakers emphasised a point made in this column in the September issue, namely, that the fullest information should be obtained by the washery designer before construction of a washing plant. He spoke of the value of the "sink and float" test, but said that even after the most elaborate preparatory tests it was not possible to say what percentage of sulphur and ash reduction in a given coal was possible until that coal had been actually treated in the washer itself.

In a paper prepared by J. R. Campbell, the Chief Chemist of the H. C. Frick Coal Co., it is mentioned that "there is considerable buncombe in the literature of some of the jig and table manufacturers regarding the reduction of sulphur by washing, who make most extravagant claims for their particular apparatus."

The ability of a washer to reduce a sulphur content in coal depends altogether on the form in which the sulphur is contained in the coal. There are a number of ways in which this can be ascertained, and no manufacturer can state until he has made his tests what persentage of sulphur is removable by mechanical separation.

The trend of the discussion on coking temperatures suggested that there is much yet to be learned regarding the behavior of sulphur in coal in the coking process, and as it is evident that such finely disseminated sulphur as that mentioned by Dr. Theissen cannot be removed by mechanical separation—so far as would appear—the most fruitful line of investigation would appear to lie in the phenomena accompanying the coking of coal, particularly the effect of initial high temperatures on the raw coal in the coke oven itself.

The interest taken in this symposium, which was largely based on papers that had already appeared in the Bulletin, suggests that the discussion of papers, after due digestion and thought, is a better proceeding than the reading of new papers at a metropolitan gathering, except of course on those rare occcasions when some epochal development in practice is ripe for announcement.

IRON-ORE ORIGINS.

In the August issue was contained the digest of a paper by Dr. A. O. Hayes which referred to the bacterial origin of the Wabana iron-ore deposit and the possibility that similarly deposited bodies of iron-ore might be found in Nova Scotia. In this connection Dr. Hayes is good enough to point out that the Mira deposits of Ordovician age and the Nictaux-Torbrook deposits of Devonian age have been partly altered from hematite to magnetite by contact with heated lava flows under pressure from overlying strata, and that this

history of alteration throws new light on the probable origin of many of our extensive bedded magnetite deposits of pre-Cambrian age in northern Quebec and Ontario and elsewhere. A specimen of magnetite from the central pre-Cambrian of Upper Canada proved to be an oolitic ore identical in appearance with the oolitic magnetite of Nova Scotia. Some interesting possibilities are suggested by this structural identity, and further investigation along this direction will be awaited with interest.

STRIKES.

The month has been of kaleidoscopic changes. On the morrow of Ben Tillett's declaration that British workers were abandoning the strike weapon came the strike of the railwaymen in Britain. Just as the steel trade in the United States was commencing to become very active, the attempt is made to compel 'closed-shop' unionization of all the steel plants there. When the public mind had finally crystallized the concept that strikes of policemen were a betrayal of public trust the Boston police force removed all dubiety from the public mind by striking and letting loose the subterranean anarchy that awaits its opportunity in every city. Our own experience of the Industrial Conference at Ottawa, while possibly it clarified some situations and helped in the matter of good fellowship between employers and their workmen's representatives, revealed a cleavage of thought that was far from reassuring. The D'Annunzio coup de'Etate at Fiume, and von der Goltz's old-time appeal to the German "Gott", the withdrawal of the British forces from Archangel—a tragic episode —and the amazing persistence of the Bolshevik regime add to the general complexity of the outlook.

Yet, withal, some general tendencies seem to emerge. The 'lightning strike' is discredited, the treasonable and subversive nature of the general strike, and the O. B. U. direct action idea has been comprehended by the general public and the more thoughtful of the labour leaders.

Still more hopeful is the general understanding of the necessity to separate industrial disputes and political aspirations. The political strike has proved too dangerous a weapon.

The present position of the labour unions is not unlike that of Germany, Austria and Russia before the war. Each of these countries was possessed of a conscript army, trained with the leading motive of quick mobilization and instant action. The rulers of these countries were poor keepers of the peace. One was an old man in his dotage, the other was weak and ill-advised, and whether the third was a knave or a fool, the world has not decided, and yet each of them possessed a deadly weapon ready for instant use. The inevitable happened.

The leaders of labour have learned the power of the strike, but they have not learned the responsibility of power or the penalty of its use. They are being taught today. The fiasco of the London and Liverpool police strike, the equally flat failure of the Boston police strike, the repudiation of the O. B. U. in Canada, the failure of the steel strike in the States, and the resentful temper shown by the British public towards the striking railwaymen, all point to the fact that thinking men are realizing that the health and lives, the earnings and occupation of men should not be jeopardized by a never-ending succession of strikes. The Executive of the railwaymen in Britain called a strike without taking a vote. This procedure does not differ in principle from the action of a general staff in adopting war measures without consulting a parliament. The principle is inherently wrong. It is one of the principles the war was fought to break and discredit.

It may be that socalled 'Labour' has had its fling, for unfortunately there is only one way to prove that certain theories are wrong, and that is to try them out. Some very far-sighted and statesmanlike utterances have been made by labour leaders recently, and it would appear as if many men in the ranks of the unions were becoming afraid of some tendencies that have showed up more clearly within the past few months. One thing however is quite clear, namely, that if labour unions want to exert their political power they must do so through the legitimate channels of the vote, and must not use their power over the lives and personal comforts of the populace to enforce preferential treatment of selected trades which are powerful because they control some necessity of civilized life.

Lloyd George, with his keen insight into the inwardness of social problems, has had flashed on all cinema screens a signed statement that the British Government is not fighting trade unionism, but an attempt by extremists to gain their ends by attacking the life of the community.

W. W. Appleton, President of the International Federation of Labour, and a leading figure in British trades unionism recently remarked:

"The flooding of mines and the cessation of work "on railways destroys wealth and rots food. It is "useless to talk of taxing wealth with chicanery and "folly have destroyed, or of enjoying food which unreasoning railway men have left to perish. Every "man and woman and child in Britain will have to "pay for the past and current week's follies, and the "poorest will pay more, because they will pay in "actual suffering, while the well paid will only incur "the disadvantages of straightened circumstances."

The "New Statesman", trying to be sarcastic at the expense of the British Government, but succeeding only in emphasising the correctness of its attitude, remarks: "What the nation has suffered in the past ten days has been a desperate attempt of the Government to recapture the middle-class vote."

The "middle-class" vote is in fact the expression of the majority of the British nation, and what the Premier is combatting is an attempt to alter the political constitution of Britain to favour a minority of the nation whose power resides altogether in the fact that this minority controls a public utility by virtue of specialized employment. It is the old story of the Praetorian Guard over again.

THE WEST INDIES.

It is difficult to believe that Lord Rothermere was sincere in his suggestion that Great Britain should sell a portion of the West Indies to the United States in liquidation of her monetary debt to that country. If he was sincere then he should be mightily ashamed of himself.

Such a suggestion, however flippantly made, takes many things for granted. It assumes that Great Britain could "sell" these islands, and could transfer inhabitants to another national allegiance. What has become of President Wilson's famous statement regarding the transfer of allegiances without the consent of the governed?

Has the treatment of the black race in the United States been of such a character as to make the coloured inhabitants of the West Indies desire to be included among Uncle Sam's children?

The writer has had occasion to observe the differing characteristics of coloured people from Alabama, and British coloured citizens from the West Indies, and the contrasts is all in favor of the West Indian. These people are well-spoken, well-mannered, decent, often deeply religious, and generally speaking desirable citizens. They are a standing tribute to British schools and the working out of British ideals.

The West Indians might feel concerned regarding Lord Rothermere's utterance, if they did not rest secure in the knowledge that such a betrayal of trust was inconceivable in Britain.

But in this matter Canada is vitally concerned. Canada has a first right to be consulted regarding any British colonies on this side the Atlantic, from Guiana and Honduras to Bermuda, nor can Canada remain aloof from political developments in Newfoundland. Canadian capital is deeply interested in all these countries. Canadian citizens are there in large numbers, often taking a prominent part in the affairs of their place of residence, and the interchange of goods between say Halifax and the West Indies is an old-established tradition.

So far as Canada's future is concerned, everything in the way of influence and importance that has accrued to the United States since the Civil War in that country may come to Canada in a like period of time. Canada is a first-rate political power on the American continent, and no British politician should be allowed to even suggest transfers of British territory on this side of the Atlantic, without hearing emphatically from Canada. The time has passed when a British politician could deal in British colonial territory. In principle, and in fact, Great Britain has no more right to "sell" the West Indies to the United States than she would have to "sell" the Niagara Peninsula, and Canada would have an equal right to protest in either case.

THE TRADE OUTLOOK.

In the July number, in an attempt to follow the tendencies of works operation in Canada, it was surmised that while the Summer would see a reduction in steel and iron outputs in Canada, there was reason to anticipate an improvement in business offering to Canadian steel plants in the Autumn. In the meantime, there has been a general suspension of blast furnace operations, but work has been continued on the cold ingots in stock. There are now indications that the stocks are used up. Extensive repairs have been made to plants, and during the period of partial idleness, orders have accumulated sufficiently to justify the expectation of a partial resumption of blast furnace operations before Christmas. It is officially announced that a partial resumption of the open-hearth furnace melting is to be made at the Nova Scotia Steel Company's plant at Sydney Mines, while at Sydney, the Dominion Steel Corporation, have resumed work at the mills on one turn.

The effect of the steel strike in the States, if it has any, on the large steel producers in Canada, will be favourable in proportion to the length of time production is impeded in the American works. It has been apparent, however, from the first day that the strike would result disastrously to the strikers, and it does not appear likely that steel production in the United States will be sufficiently interfered with to re-act favourably upon Canadian demand.

Some inconvenience is doubtless being experienced by those metal trades in Canada that depend upon United States' mills for primary products, but here again it does not appear probable that the restriction on United States' importations into Canada will be sufficiently prolonged to markedly strengthen the demand on Canadian mills for similar products of Canadian production.

It seems fairly probable that the steel business will slowly improve during the Winter, and that because of the certainty of some unemployment in Canada during the Winter and the high level of wages attained by those steel workers who are fortunate enough to retain employment, no serious trouble in labour questions is likely to arise at the Canadian steel plants in the near future.

OUR MARITIME LETTER.

We have arranged for a monthly letter from the Maritime Provinces intended to give a general but accurate impression of business and trade conditions prevailing there as they affect the iron and steel industries. Our correspondent is in a position to view the business side of the industry as distinguished from the operating side, particularly with regard to the movement and selling prices of raw materials.

As the situation in the Maritime Provinces is singular and not necessarily comparable with Upper Province trade conditions, we believe our readers will appreciate this letter, which is hoped to make a permanent, and we anticipate, a valuable feature of our columns.

It is announced that the Calumet & Heel Mining Company has employed Professor Graton to make a complete geological survey of the entire territory owned or controlled by this Company's mining interests in Northern Michigan, 23,000 acres in all. Three assistants of Prof. Graton are already engaged in preliminary mapping. The work was outlined and planned two years ago by General Manager MacNaughton, but Prof. Graton had to be released for war-work. It is stated the work will occupy two years, and permission has been granted to the geologists to examine all underground workings in the territory covered, as is is realised the survey will be of common benefit. The Calumet & Hecla Company bear all expense. Work was decided upon from a study of the district and a realization that every ore formation so far uncovered had been found as the result of accident, and not as the result of geological deductions.

The action of the Calumet and Hecla Company is excellent confirmation of the views expressed in our August issue as to the necessity for the employment of geologists by companies controlling large mineral areas, and it may be confidently anticipated that the Calumet and Hecla management will be amply rewarded by the results of its initiative.

FOR STARTING THE ACTION.

A prominent trade paper in Canada referring to the effect of the steel strike on Canadian steel mills, says: "It can be accepted as a fact that it is not possible for "industry on this side of the line to prosper while the "same business across the border is in the throes of "a desparate strike."

It is also stated that "plates, tubes and large struc- "turals are the lines that we must import."

Is this quite so? Why **must** we import these articles? If we are so very dependent on the United States is is perhaps as well to know it, but Canada is in a position to make a few things, and she is placing herself in a position to make more.

It is significant that the British Iron Steel Institute at its Autumn meeting should have devoted the session entirely to the consideration of the question of Fuel Economy.

The joint report of the Committee on Fuel Economy prepared by Dr. W. A. Bone, Sir Robert Hadfield and Mr. A. Hutchinson—representing the British Association—was presented. Another paper was read on fuel economy as practised in German iron and steel works.

We believe the lessening of fuel costs is the chief problem before the iron and steel industry today.

ASIATIC COAL SUPREMACY.

The "Journal" reprints a condensed extract from the **Economiste Francaise** on the coal resources of the world, which is interesting in that the writer, Gaston Cadoux, has grasped, what the "Journal" several years ago pointed out, that the great anthracite reserve of the world lies in the Continent of Asia, and nearly all of it at that within the borders of China. M. Cadoux points out that it is already established that in China alone there is four times as much anthracite as in the rest of the world put together, and that while the coal reserves of Europe and America are fairly well defined as to quantity, the coal occurrences of China are only partially prospected.

China is one of the mysteries of the present age, and a greater mystery of the future. A perusal of the history of China will reveal that this vast territorial unit has passed through periods of magnificence, followed by periods of decay and again followed by a rise in extent of territory and government, that have succeeded each other with almost monotonous alternation. In the history of China, the record of a single dynasty may cover 600 years, and be but an episode in the long story of successive decline and rise of national importance.

Should China repeat her traditional historical phases, and under some strong hand rise once more with all the resources of modern science, backed by internal reserves of coal and iron that exceed those of all the outer world what may not this patient and resourceful nation achieve?

Many careful people fear the rise of Japan as a world power, but Japan must always be limited by her small resources of coal and iron, and by the small extent of her native islands, and the potentialities of the Japanese are meagre compared with the infinite possibilities of China. The vast reaches of Asia which lie between Tibet and the headwaters of the Yang'tse, are unknown, but time was when the rule of China extended to the borders of India. It may conceivably do so again.

If it is true that national power is derived largely from the possession of coal and iron, and who can doubt it after 1914-1919?—the hordes of Cathay are worth our attention. They have the essential raw materials of modern industrial civilization, they are very very numerous, and their form of national culture, while it may not appeal to Western minds, has not indeed occasioned a greater catastrophe than befell Europe but lately.—Canadian Mining Journal.

Slag Aggregates in Concrete and Mortar

By EMMANUEL MAVAUT (Montreal, Canada).

Report of Comparative Tests of Basic Steel Slag, Limestone and Banc Rouge used as the coarse aggregates in Concrete, also Basic Steel Slag Screenings, Commercial and Standard Sand used as fine aggregates:

Purpose of Tests:

The purpose of this series of tests is to furnish preliminary information re. the use of Basic Steel Slag for concrete materials as follows:—

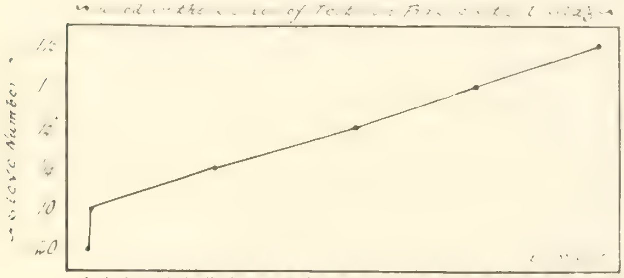
(a) A comparison of the crushing strength of Basic Steel Slag, Limestone and Banc Rouge when used as the coarse aggregates in concrete, tests to be made at the end of 14, 30, 49, 60, 70 and 90 days.

(b) A comparison of tensile strength between slag screenings, commercial sand and standard sand, test to be made at the end of 14, 30, 49, 60, 70 and 90 days.

(c) To determine the granulometric analysis of the materials as used in the different tests, also the other physical characteristics.

Coarse Aggregates:

Upon receipt of the different coarse aggregates, viz.: Slag, Limestone, and Banc Rouge, it was screened through a set of sieves ranging from 1½ inch to ¼ inch in order to determine the proportion of mixture of each. As the proportions in the three aggregates under consideration were vastly different it was decided to separate the different sizes, that is the ¼, ½, 1, 1¼, and 1½, and label them accordingly until prepared to proceed with the experiment.



Recombining of Coarse Aggregates:

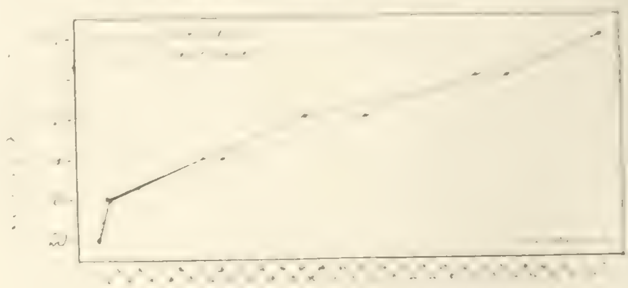
In order to make a true comparative test, and at the same time to follow "Fullers Curve" which is practically a straight line, all the aggregates were recombined by weighing the same quantity of ¼ inch, ½ inch, and 1 inch material. The 1¼ and 1½ inch were left out for the reason that we could not secure enough of the large size aggregate, the whole being thoroughly mixed together by turning them over and over again with a shovel until of uniform appearance.

At the conclusion of the recombining process the different aggregates were sieved, and the following results were obtained:

Per-cent by weight passing sieve number:

No.	Slag.	Banc Rouge.	Limestone.
20	0.00	0.00	0.00
10	0.80	2.00	2.20
¼	24.80	24.60	21.00
½	[illegible]	53.20	41.40
1	76.00	75.10	81.00
1½	100.00	100.00	100.00

As seen by the above results and curves. Fullers Curve is obtained in the three aggregates as required.

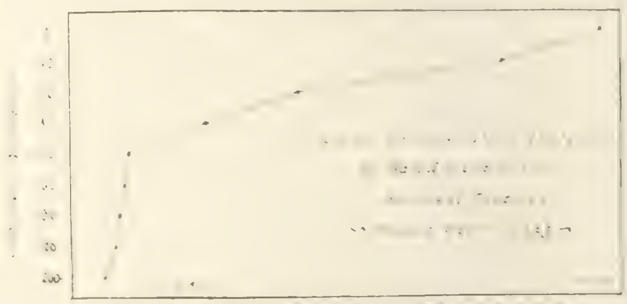


Fine Aggregates:

It was intended at first to screen the fine aggregates in the same manner and using the same method of recombining as with the coarse aggregates, perhaps using three or more sands but, as the sand selected was well graded it was used in its natural state throughout the whole series of tests.

Below are the results of tests made on sand as received; also curve of sieve analysis of same:—

Per-cent by weight passing sieve No. 200	[illegible]
" " " " " 100	[illegible]
" " " " " 80	[illegible]
" " " " " 60	6.40
" " " " " 50	7.50
" " " " " 40	22.60
" " " " " 30	40.60
" " " " " 20	80.50
" " " " " 10	100.00
Percentage of Voids	41.00%
Specific Gravity	2.60
Weight per cubic foot	95.87
Percentage of Silt	[illegible]



The cement exclusively used for these tests was manufactured by the Canada Cement Company, at their Longue Pointe Plant. This cement was sampled and tested before proceeding with the series of tests on the concrete. The results of tests made on the cement follows:—

Setting: Initial	3 hours [illegible] minutes
" Full	6 hours 10 minutes
Specific Gravity	3.146
Sieving: Per-cent passing sieve No. 100	[illegible]
" " " " 200	96.2

[illegible]

Tensible Strength:

	NEAT.			3 to 1	
	24 Hours.	7 Days.	28 Days.	7 Days.	28 Days.
	420	685	800	300	350
	430	740	800	285	390
	390	730	850	280	395
Average	413	718	817	288	378

Specific Gravity of Aggregates:

In order to arrive at the right proportion of mixture the voids had to be obtained and, as we have found by past experience that the dry method of determining same was more uniform than the wet process, the specific gravity had to be obtained on all aggregates both fine and coarse. Same was obtained by the following process:—

500 c.c. of water was put in a 100 c.c. graduate then 500 grams of aggregates under test poured in the water slowly. The specific gravity therefore was 500 divided by the computed weight of displaced water.

The following is the specific gravity obtained on all material to be used in these tests.

Slag	3.57
Limestone	2.77
Banc Rouge	2.50
River Sand	2.63

Determination of Voids:

..Determination of voids were made on the various aggregates after being separated in different sizes and again after recombining, same were obtained by the following method:—

1000 c.c. of material under test was weighed and then divided by 1000 which gave the weight per c.c. this was in turn divided by its specific gravity and multiplied by 100 this giving the per-cent of solid contents which when substracted from 100 gives percentage of voids.

The following are the percentage of voids obtained on all aggregates:—

	Basic Steel Slag.		Banc Rouge		Limestone.	
	1 inch	55.53	1 inch	54.00	1 inch	57.55
	½ "	56.42	½ "	53.28	½ "	52.50
	¼ "	56.30	¼ "	52.00	¼ "	53.93
Below	¼ "	55.80				
Recombined		53.91		39.84		48.60

KIND OF MATERIALS USED:

CEMENT - RIVER SAND AND BANC ROUGE

PROPORTION OF MIXTURE 1 - 2 - 4

LABORATORY NUMBER	MARK ON CYLINDERS	DATE MADE	DATE BROKEN	AGE IN DAYS	WEIGHT OF CYLINDERS LBS. OZ.	CRUSHING STRENGTH LBS. PER SQ. INCH	AVERAGE CRUSHING STRENGTH LBS. PER SQ. INCH
[illegible]	[illegible]	[illegible]	[illegible]	14	[illegible]	[illegible]	[illegible]
	[illegible]	1917	1917		[illegible]	[illegible]	
[illegible]	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	1	1917	1917		[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	Oct. 11	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30 —	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]	1967	
[illegible]	[illegible]	[illegible]	[illegible]	70	[illegible]	[illegible]	[illegible]
	[illegible]	1917	[illegible]		[illegible]	[illegible]	
[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible] 7	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	

Weight Per Cubic Foot:

In order to proportion the concrete with accuracy, the weight per cubic foot was determined on all materials using the following method:—

The specific gravity of the material under test was multiplied by 62.5 (62.5 being the weight of a cubic foot of water) the results were multiplied by voids and then substracted from first weights viz:—

62.5 x specific gravity = pounds

$$\text{Pounds} - \frac{(\text{pounds x voids})}{100} = \text{weight per cubic ft.}$$

The following are the weights per cubic foot of the different aggregates obtained by the above method:

Recombined Slag	102.82
Recombined Banc Rouge	94.00
Recombined Limestone	88.96
Crushed Slag	98.62
Commercial River Sand	95.62
Cement (Standard of 100.00 was used.)	

Proportioning Concrete:

We could not combine the cement and sand with the Slag, Limestone or Banc Rouge as the case happened to be and conform to "Fuller's Curve" and at the same time have tests that we could compare with each other on the plan of using equal proportions of cement and sand so it was found necessary to determine the proportion of mixture necessary to produce a dense concrete when using the coarse aggregates having the highest percentage of voids which in this particular case was the slag and use the same proportion throughout the series of tests on all materials, accordingly a mixture of one part cement two parts sand and four parts coarse aggregates was used.

One advantage in using 1: 2: 4: mixture is that it is very commonly used and a great deal of information and results can be found for comparison.

KIND OF MATERIALS USED:

CEMENT - RIVER SAND AND LIMESTONE.

PROPORTION OF MIXTURE - 1 - 2 - 4.

LABORATORY NUMBER.	MARK ON CYLINDERS	DATE MADE	DATE BROKEN	AGE IN DAYS	WEIGHT OF CYLINDERS LBS. OZ.	CRUSHING STRENGTH LBS. PER SQ. INCH	AVERAGE CRUSHING STRENGTH LBS. PER SQ. INCH.
8980	33	Oct. 18	Nov. 1	14	30 - 00	702.41	784.55
	32	1917	1917		29 14	866.69	
8980	31	Oct. 17	Nov. 17	30	29 - 15½	1628.77	1716.25
	30	1917	1917		30 - 2	1803.94	
8925	29	Oct. 17	Dec. 7	49	30 - 5	1529	1829
	28	1917	1917		30 - 4	2128	
8925	27	Oct. 17	Dec. 17	60	30 --	2035	2145
	26	1917	1917		30 - 12	2256	
8925	25	Oct. 17	Dec. 26	70	30 - 4	2218	2543
	7	Oct. 7	Dec. 16		30 - 6	2868	
8925	6	Oct. 7	Jan. 7	90	30 --	X	3829
	5	1917	1918		30 - 7	3829	

Cylinder No. 6 was not reported as it broke way below the average due to it not having been placed properly in the machine.

Proportioning of Mortar for Tensile Strength tests:

Seeing that all specifications call for 3 to 1 mortar and that an unlimited amount of data can be gathered when using that proportion it was decided to use it.

Method of Mixing Test Specimen:

For concrete cylinders—Enough material to make (6) six cylinders was mixed at on time, a galvanized iron pan four feet square having sides four inch high

KIND OF MATERIALS USED:

[illegible] SAND AND BASIC STEEL SLAG

PROPORTION OF MIXTURE - 1 - 2 - 4

LABORATORY NUMBER	MARK ON CYLINDERS	DATE MADE	DATE BROKEN	AGE IN DAYS	WEIGHT OF CYLINDERS LBS. OZ.	CRUSHING STRENGTH LBS. PER SQ. INCH	AVERAGE CRUSHING STRENGTH LBS. PER SQ. INCH
[illegible]26	40	[illegible].26	Nov [illegible]	14	33 6½	[illegible]	[illegible]
	39	1917	1917		33 3	1[illegible]60	
9026	38	Oct. 26	Nov 2[illegible]	[illegible]	33 -15	1	[illegible]
	37	1917	1917		33 -10	[illegible]	
[illegible]	36	Oct. 26	Dec. 14	4[illegible]	[illegible] -12	17[illegible]	[illegible]
	3[illegible]	1917	1917		33 -15	[illegible]	
[illegible]	34	Oct. 26	Dec. 26	[illegible]	33 -14	1954	2024
	24	Oct. 16	Dec. 16		33- 12	2095	
[illegible]	23	Oct. 16	Dec. 25	70	34 --	24[illegible]	25[illegible]1
	22	1917	1917		33 -15	270[illegible]	
[illegible]	21	Oct. 16	Jan. 16	90	33 -14	2452	2241
	20	1917	1918		33 - 5	[illegible]	

1. Brake of No. 38 was not considered on account of its Top & Bottom not being parallel --

was used as a mixing receptacle, the whole bottom of the pan was covered with the required quantity of sand and the cement spread over it. The two ingredients were then mixed together by one man until they appeared to be of a homogenous condition, four and sometimes five turnings being required. The required amount of coarse aggregate was then spread over this mixture and the whole again thoroughly mixed in the same manner as mentioned above. After this was done a measured amount of water was added a little at a time until the right consistency was obtained. Although the concrete mixed with the different coarse aggregate required different quantity of water, an attempt was made to put the right amount in each batch in order to obtain the same consistency for all the cylinders without considering the amount of water used.

Method of Making Test Specimen:

The test pieces were molded in galvanized iron molds six inch in diameter by twelve inches high. A quarter-inch plate glass was used as a bottom to each cylinder. When the concrete was thoroughly mixed is was poured into the molds in layers of about two inch thick and each layer tamped with a wooden rod 1½" in diameter, when a cylinder was finished it was at the top with a six inch trowel to form a smooth upper surface. After a couple of hours the concrete had slightly settled and it was necessary to finish the

KIND OF MATERIALS USED:

CEMENT - SLAG SCREENINGS AND COARSE SLAG.

PROPORTION OF MIXTURE - 1 - 2 - 4.

LABORATORY NUMBER	MARK ON CYLINDERS	DATE MADE	DATE BROKEN	AGE IN DAYS	WEIGHT OF CYLINDERS LBS. OZ.	CRUSHING STRENGTH LBS. PER SQ. INCH	AVERAGE CRUSHING STRENGTH LBS. PER SQ. INCH
8923	4	Oct. 4	Dec. 13	70	33 - 14	1885	1823
	3	1917	1917		33 - 12	1761	
8923	2	Oct. 4	Jan. 4	90	33 - 14	×	2395
	1	1917	1918		33 - 15	2395	

top of the test piece with a mixture of Plaster of Paris and cement, a very mushy mixture being used. This was finally trowelled off until a perfectly smooth surface was obtained.

The specimens were kept in the molds for 48 hours after which they were turned over, the plate glass bottoms were removed and then the bottoms were recapped in the same manner as the top was 48 hours previously. This gave a perfectly square specimen, having its sides at right angle to its top and bottom. A couple of hours after, the specimens were removed from the molds and then stored in damp sand for 45 days after which they were removed and stored in air of about 70°F. temperature. Of course, the specimens to be tested inside of 45 days were taken directly from the damp sand and broken without being stored in air.

Mehtod of Mixing Test Specimen for Tensile Strength:

The method used for making all briquettes for the sand (River) and Standard sand was that recommended by the American Society of Testing Materials.

Below are the results obtained on the test for tensile strength of the standard and commercial sands also slag briquettes:—

Standard Sand and Cement:

Age of Briquettes When Broken.

	2 Weeks lbs.	1 Month lbs.	7 Weeks lbs.	2 Months lbs.	10 Weeks lbs.	3 Months lbs.
	320	360				
	380	395				
	390	375				
Average	363	377	470	418	470	485

Slag Screenings that passed ¼ mesh sieve and cement:

	2 Weeks lbs.	1 Month lbs.	7 Weeks lbs.	2 Months lbs.	10 Weeks lbs.	3 Months lbs.
	520	580				
	450	575				
	480	600				
Average	483	585	613	642	[illegible]	765

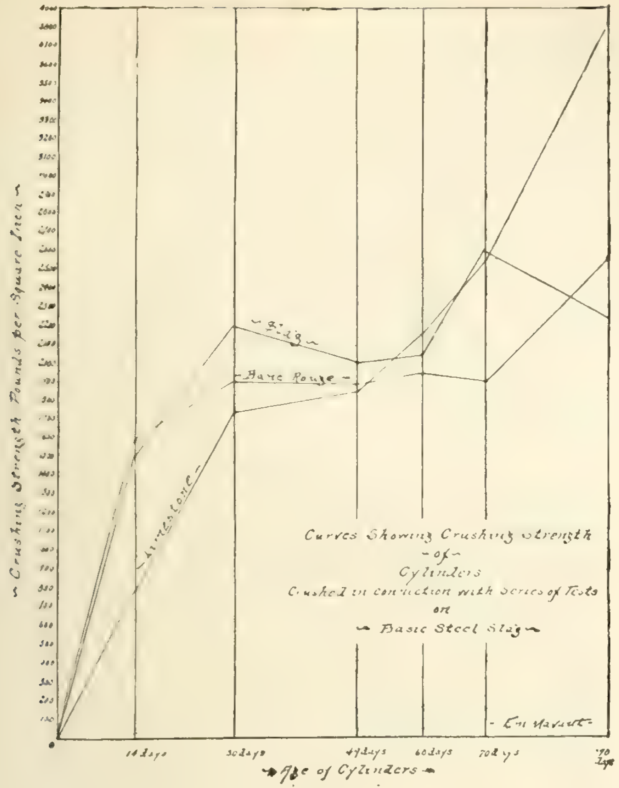
Slag Screenings that passed No. 10 sieve and cement:

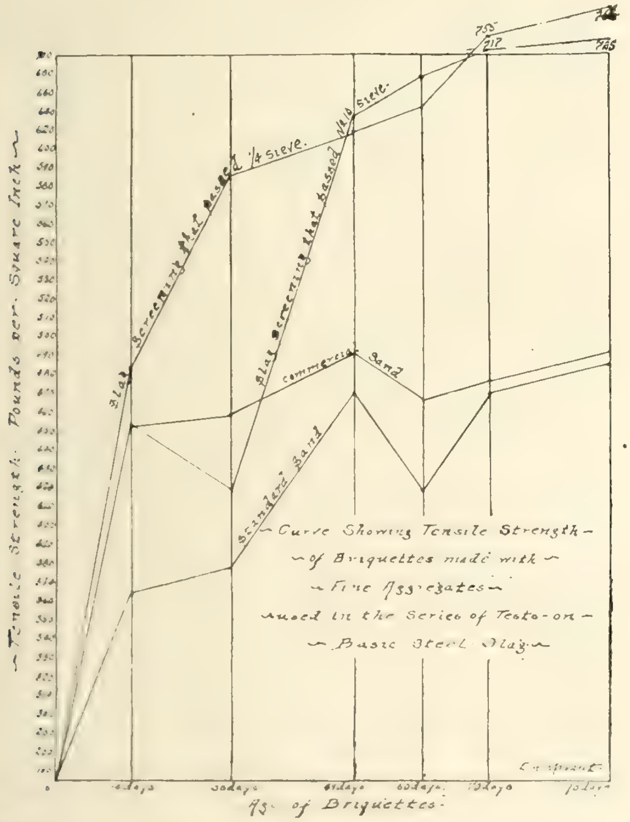
	2 Weeks lbs.	1 Month lbs.	7 Weeks lbs.	2 Months lbs.	10 Weeks lbs.	3 Months lbs.
	465	390				
	420	425				
	475	440				
Average	453	418	633	675	717	725

Commercial Sand and Cement:

	2 Weeks lbs.	1 Month lbs.	7 Weeks lbs.	2 Months lbs.	10 Weeks lbs.	3 Months lbs.
	455	460				
	460	465				
	440	450				
Average	452	458	492	467	477	492

Tables and curves accompany, showing the crushing strength of the cylinders tested, and their increase in strength with age, from which the comparative behavior of the materials employed may be ascertained.





Note:

The materials used as the coarse and fine aggregates were secured from the following firms and localities:—

Slag:

The Canadian Steel Foundries, Limited, Montreal, (from Welland Ontario works.)

Limestone:

Morrison Quarry Company, Montreal, Que.

Banc Rouge:

Martineau Quarry, Rosemont, Que.

Sand:

Montreal Sand and Gravel Company, Montreal (from Lake of Two Mountains, Que., opposite Oka.)

Cement:

Canada Cement Company, Montreal. (Plant No. 1, Longue Pointe, Que.)

HYDROELECTRIC POWER AND CANADIAN IRON ORES.

Application of hydroelectric power to mineral development was the topic dealt with recently by J. Walter Evans, Belleville, Ontario, at a meeting of the Hastings County branch of the Canadian Mining Institute. The production of electric energy that will sell at $10 per hp. was declared by Mr. Evans to be possible, for use in develop a steel industry in Hastings County. "In late years the development of the electric furnace has demonstrated that magnetite ores high in sulphur and magnetite ores high in titanium can be smelted successfully in the electric furnace," said Mr. Evans. "With power at $10 per hp., and charcoal at $14 per ton, pig iron can be made at the rate of 100 tons per day at a cost of $25 per ton. There is available in Hastings County over 20,000,000 tons of iron ore." The speaker has located several ore bodies that strongly attract the magnet which are as yet untouched and are not included in the above estimate.

There are other uses for electrical power, such as smelting molybdenite concentrates for the manufacture of ferromolybdenum. There are large bodies of sulphide ores suitable for the manufacture of sulphuric acid, and the iron residue plant makes a very fair iron ore. It is too high in sulphur to be used in a blast furnace without mixing it with low sulphur ores, but with electric furnace treatment it makes a good grade of low sulphur pig. If a smelting plant were built at Belleville, Ont., of a size sufficient to treat 200 tons a day, it would mean the use of 15,000 bp. and the development of a steel industry which would in turn bring many other industries in its train. Very little is known at the present of the composition of many of Hastings County ores; as an instance, it has been shown that the titaniferous ores carry 0.4 per cent vanadium and that the vanadium can be retained in the pig iron, and the titanium slagged off.

There is no question about the quality of the metal made from these titaniferous ores in an electric furnace, claimed Mr. Evans, and, with the enormous bodies of ore which are to be found throughout Canada and the amount of water power available, in many cases as yet undeveloped and in close proximity to the ore deposits, an industry started in Belleville would develop others of like nature in other parts of Canada, so that Hastings County, which was the pioneer county in mining the first iron ore mined in Ontario, and the pioneer in the direct smelting of titaniferous ores, may yet be the pioneer in the iron and steel industries in Ontario, utilizing all Canadian ores and all Canadian reagents for the complete conversion of ore into refined steel.

THE PLANT EXTENSIONS OF THE DOMINION STEEL CORPORATION.

The extensive programme of additions and modernization of plant which the Dominion Steel Corporation has for some time been employed upon is now approaching completion, and a general survey—which it is hoped later to supplement by more detailed particulars and photographs—is of timely interest.

Plate Mill.

This is a 3-high, 110 inch. sheared-plate motor-driven mill. It will roll from 3/16 inch up to the large plate required by Lloyds, and a maximum output of 12,000 tons per month is anticipated.

The furnace building is 140 ft. by 227 ft. The steel framework of this building is in course of erection.

The shear building, which is almost complete, is 300 ft. long by 350 ft. wide.

The mill building is 80 ft. long by 250 ft. The slab-crane runway is 80 ft. by 200 ft., the conveyor hot-bed 100 ft. by 560 ft.

The main motor, weighing 500 tons, is 4,000 h.p., 82 revs. with suitable pinion reduction.

The heating furnaces will be gas-fired, the gas being obtained from the new coke-oven plant.

The site of the mill has been chosen with regard to the transportation of ingots from the open-hearth furnaces, and the company was fortunate in having a central site within its works with a solid rock bottom which has enabled the foundations of the new mill to be put in with exceptional solidity.

Power Plant.

In addition to the large amount of electric power required to operate the Plate Mill, the Company had decided on a policy of electrifying all the mills and substituting electric power for steam wherever possible. As a necessary part of this programme a new central power station is being provided. The generators comprise one 5,000 kw., two 3,000 kw., and one 500 kw. turbo-alternators, and one 1,000 kw. motor generator. Steam for operation of the turbines will be provided by boilers fired by waste blast-furnace gases. Additional pumping equipment is also being provided for the turbine condensers. The new power-house is 80 ft. by 100 ft., fireproof construction and equipped with a 50 ton overhead crane. Space has been left for additional generating capacity. The 28″ rail-mill is being equipped with a motor to replace the steam engine previously used there.

The general layout of the Dominion Steel Company's plant has not hitherto been remarkable for its fuel economy, which is not surprising in view of the remarkably low price fixed by the contract with the Dominion Coal Company. Under the consolidated arrangement of the two companies, however, the necessity for fuel economy has become extremely pressing in view of the increase in the costs of coal production and the extreme improbability of any permanent retardation of the increase in the cost of coal production which the Dominion collieries, along with the rest of the world, must expect in the future. This statement must not be misunderstood as intimating that any special difficulties are to be apprehended in the Dominion Coal Company's practice, but merely to point out that the Sydney companies, in common with all other coal operators, must expect a steadily rising factor of coal cost.

It is interesting to note, therefore, that all the extensions carried out or contemplated by the Dominion Steel Corporation keep prominently in mind the necessity to reduce fuel costs.

Coke-Ovens.

The new ovens are giving most satisfactory results, but, owing to the shut-down of the blast furnaces, only sufficient coke is being made to keep the ovens warm. The new coke-plant of the Dominion Steel Company is the finest in Canada, and equal to any in North America, in efficiency, if not in size.

The Collieries.

The reduction in outlet for the coal produced by the collieries occasioned by the lessened quantity of coke required is now being made up by the demand from Europe, at the moment greatly increased by the railway strike in Britain. The demand for coal for export from North America is only limited by the shipping tonnage available.

A number of projects are under way or in contemplation at the collieries. A new shaft, for ventilation pumping and man-hoisting, is being sunk between the No. 1 and No. 2 collieries, and is about halfway down to the Phalen seam, which it is intended to tap. A similar shaft, with a like purpose, is projected near the Caledonia Colliery. The work of re-habilitating and equipping No. 12 Colliery, which was interrupted by the war is resumed. Prospecting operations looking towards the opening of one of the lower seams are in progress. At one or two of the collieries exhaust-steam turbines are being installed, and the policy of using electric power wherever possible, which was commenced some fifteen years ago, is being continued. A large turbo-generator set purchased for the Springhill Mines before the war is in process of erection, but this has been much delayed by the impossibility of getting parts.

The development of new collieries, which is a never-ending necessity in a large coal property, has been suspended since 1912, and it is therefore to be expected that future appropriations of the Dominion Steel Corporation will contain large provision for the development of new mines.

With regard to the immediate future of the operations at the Sydney Plant, "Iron and Steel of Canada" is informed that it is intended to resume operations commencing about October 10th on one blast furnace, two 100-ton and five 50-ton open hearth furnaces, single turn on the blooming mill and single turn on the billet mill.

At the present moment the rod mill and wire mills are operating, and have been operating continuously. In addition, the coke oven have been running on the smallest possible output sufficient to keep them in good condition. This department will of course operate on a larger scale as soon as the furnaces are started up.

Under the intended scale of operations, the output of steel ingots will be about 15,000 tons monthly.

NEW GLASGOW NOTES.

The business outlook at New Glasgow, while not giving very encouraging prospects for the future, is on the whole, at present, good. All the manufacturing plants are operating, and while no large orders are being booked, there appears to be considerable business in hand which will ensure continuous operations for some time.

Operations at the Trenton Plant of the Nova Scotia Steel and Coal Company have been somewhat curtailed during the past month, about 75 per cent of the capacity working force being employed.

MacKay & Fraser, Limited, successors to the Canada Tool & Specialty Company and Murray & Fraser, report business good in the gas engine line. The new foundry building recently erected is not yet fully equipped, and the company is therefore, not yet in a position to produce to their maximum capactiy, but are finding a ready market for their present output. This firm, while but a few months old, have in that time been very much encouraged by the numerous enquiries for their product, and the prospects of future business are particularly bright. They will specialize on the manufacture of the Fraser Marine Gas Engine.

Messrs. J. W. Cumming & Sons, Limited., also retrpc good business. They are handling a considerable tonnage in small ship forgings, such as ship's knees, etc.

The I. Matheson & Co., Limited, are producing considerable tonnage in boiler and general plate work, as well as in the various products of their foundry.

The Maritime Bridge Company, Limited, have their plant working about 75 per cent capacity with business on their books sufficient for the next few months.

OUR MARITIME LETTER.

The Business Situation.—The Exchange Discount affecting United States Sales.

Recently several large firms have proposed to their large Canadian customers the sharing of the discount rate on Canadian currency.

This is most gracious act and the spirit that prompts it a commendable one; as a long sighted sales policy however it will bear further investigation, and if adopted generally would appear to work out as follows,—Should the Canadian customer yield to his inclination and reciprocate by continuing and increasing his purchases the already overlarge debit trade balance would be increased, causing higher premiums on New York funds on account of the greater Canadian demand, resulting in further depreciation of the Canadian currency.

The American firm would accordingly be called upon to share in an increasing discount rate until obliged to withdraw his proposal and be in a poorer position than the original one.

It would seem that the proper manner to accomplish the same object would be for the American public to invest their large surplusage in the goods and securities of the countries to whom they wish to export, thus giving them credit which they in turn might exchange for American goods.

This very question is to-day having the serious consideration of the bigger business interests and we may expect, that very shortly, active measures will be provided to supply these credits.

MARKET NOTES.

COAL.—Very interesting figures are given in The Weekly Digest of the National Coal Association with regard to the world supply of this commodity. Exclusive of the domestic production the export requirements of coal for the world is about 180,000,000 tons and the total available to meet this, but not including the United States is about 98,000,000 tons, leaving a balance of 82,000,000 tons to be supplied by them. The prospects of securing bottoms to carry this quantity are most remote, even if the coal were available. The output of American coal for 1919 must be some fifty to seventy million tons less than in 1918.

With the great demand and the small prospects of satisfying it, it will truly be an extraordinary abnormal condition which will prevent higher prices on this basic commodity.

We venture the statement that the Canadian railroads will carry more coal this winter than any time in the past.

STEEL.—The big steel strike is an accomplished fact, althought just what percentage of strikers are employees of the Steel Corporation has not yet been definitely stated. With the steel mills working at about 80% capacity and a falling export market it would seem that the Unions have not selected what might be termed the psychological moment for such a step. The position taken by Judge Gary apparently has the universal sympathy and backing of the public.

When it is considered that the average wage per man is to-day at the rate of $1,950 per annum any accusation that a fair wage is not being paid does not appear justifiable. Figures on other lines of business are not so easily available, but exclusive of the railroads we hardly think they would compare favorably with the wages of the steel corporation employees.

That the strike will be of any lengthy duration does not seem probable although new factors may enter which may prolong it indefinitely.

With the falling off of exports and in view of the fact that the mills have only been working at approximately 80% of capacity an increase in steel prices is not to be looked for shortly, although some of the more refined manufactures may advance slightly.

COPPER.—The market for this product is rather sluggish at present compared with its activity a few months ago. The immense export demand has not materialized no doubt principally because a satisfactory system of financing has not yet been arranged with the various nations. That there will be an ultimate heavy demand is beyond question, but at present food products are the first consideration and the importation of them is helping to further reduce the value of the currency.

EXCHANGE.—Sir George Paish seems to have been pretty near the mark when he predicted Sterling exchange at $4.00. A mark of $4.12 has been reached already, much to the concern of the American business man who is anxiously watching the export market. Free Trade evidently has the property of raising an invisible tariff wall which is difficult to surmont. With the large requirements of foodstuffs and coal it is not at all improbable that $4.00 Sterling will be reached. For the present the Canadian is winning in a monetary way in paying for goods which were purchased months ago, by buying sterling at the lower figure.

WIRE ROPES.—The only competitor of the Canadian wire rope makers in Canada is the British manufacturer, but with the increasel fuel costs in the British Isles and a strong demand for the special steels from which the ropes are made, this competition will not be as keen but that the Canadian maker will be thinking of higher prices.

BRICK.—Good grade firebrick from the United Kingdom are quoted at from 165 shillings to 185 shillings per thousand and advices from there indicate an upward tendency.

FLUORSPAR.—Fluorspar gravel containing 73 to 78% calcium fluoride is quoted at 22 shillings to 24 shillings per ton of 2240 lbs. F.O.R. English ports.

FERROMANGANESE.—The market on this commodity is rather dull at present and the American quotations are in the neighborhood of $105 per ton. With the steel strike on and the consumption consequently reduced, there is likely to be very little price movement.—A.M.S.

SCOTIA DIRECTORS SAIL FOR EUROPE.

Mr. D. H. McDougall, President of the Nova Scotia Steel Company, Colonel Cantley, of the National Railways Board and a director of Scotia, and Mr. W. D. Ross, a director of the Royal Bank of Canada and of Scotia, accompanied by their secretaries sailed for England on the 8th October.

Before sailing, Mr. McDougall gave out an interview to the newspapers. Mr. McDougall stated:

The principal object of the trip is to endeavor to lay a solid foundation and make connections for future development of Scotia. The securing of more shipping will be one of their endeavors, so as to place the company in a position to regain markets that had to be abandoned during the war. Mr. McDougall warned against expectation of an immediate rush of orders as a result of their trip. They were looking ahead some years, he said, and if the foundation was laid for future trade, even without much business for the immediate future, it would be considered satisfactory.

Scotia Coal had already been sold in Holland and in substantial quantities in the Mediterranean, most of this being exported in the company's own boats. Some enlargement of this trade was hoped for, but the company had greater expectations as regards the sale of iron ore. It was expected to build up a large market for the Wabana ore in Great Britain. With this in view, the company was pushing development of its Wabana iron areas, so as to make available for shipment a large proportion of the excellent ore from this deposit, which Mr. McDougall considers the finest in the world of its kind. It was also expected to make preliminary arrangements, which in a comparatively short time would lead to orders from abroad for steel cars and heavy forgings used in ships, for which work the Scotia plant is well equipped.

Amalgamation Talk.

Asked about the Scotia Steel-Scotia amalgamation talk, Mr. McDougall said that as far as Scotia was concerned there was absolutely nothing doing in that direction at present, and whatever, the opinion had been in the past, his company was not disposed to consider amalgamation at the present time. As regards the submarine area question, Mr. McDougall said there were no new developments. The matter was in the hands of the Government and Scotia awaited their further action with entire confidence as to the outcome.

Concluding the interview, Mr. McDougall said he expected improved conditions next spring of which Scotia counted upon obtaining a substantial share. There would be in the next future, he thought a more extensive development of the coal field and a larger production from the steel works.

Mr. McDougall expects to visit the principal iron-ore districts in Britain, France, Spain and the Scandinavian Peninsula, and also to visit Italy and possibly the Levantine countries.

OVER PRODUCTION OF FERRO-CHROME IN FRANCE.

The following statement regarding the production of ferro-chrome in France has been received from the office of the Commissioner General of Canada in France.

Having received a letter asking what market there would be in France for Canadian ferro-chrome, inquiry was made. The Ministère de la Reconstitution Industrielle (Direction des matières Premières), 74 Avenue des Champs-Elysées, Paris, made the following statement: "I beg to inform you that France has always been an exporter of ferro-chrome, both ordinary and refined, the production of its factories greatly exceeding the national consumption. Our electro-metallurgical works also manufacture the other ferro-alloys (tungsten, molybdenum, nickel, etc.) in sufficient quantities."

A letter from the Comptoir Français de Ferro-Chrome, 7 Avenue du Coq, Paris, addressed to the Union des Industries Métallurgiques et Minières, 7 rue de Madrid, Paris, said: "We beg to return herewith letter from the Commissioner General for Canada which was enclosed in yours, and would ask you to advise him, in connection with his request for information concerning the market in France for ferro-chrome and other ferro-alloys manufactured by Canadian works, that said works stand no chance of success, for the electro metallurgical industry of this country, by reason of its large production, is itself obliged to find a market in foreign countries for its production of ferro-alloys of all kinds. In short, the production in France of these alloys exceeds the country's requirements, and the stocks actually available in the works are sufficient to cover the needs of the French market until the beginning of next year and even beyond that time. We would add further, that our electro-metallurgists have taken steps so that the French Government will close the market for ferro-alloys to all foreign importation."

Mr. Antonin Parouty, chemical engineer, 11 Rue de Prague, Paris, said: "The factories that have been engaged in producing ferro-chrome, many of them 15,000 horse-power, have been all obliged to close down and many of them are considering manufacturing something else, if they have not done so already. These factories are splendidly installed and mostly in the French Alps, i.e., in the Departments of Savoie and Hautes-Alps (Douphiné and Grésivaudan)."

Speech by Col. Thos. Cantley on the Eight Hour Day before the Industrial Conference at Ottawa, Sept. 17th, 1919

Mr. Chairman, ladies and gentlemen: Many of the speakers on both sides of the Chamber have thought it necessary to refer to the early age at which they entered their life's struggle, the lowest age yet claimed being eleven years. I will not detain you with any data as to my youthful experience, and my autobiography has not yet been written. Some of my early life history is known to my good friend Premier Murray, who with two members of his Cabinet are now with us. I only hope Premier Murray will not tell all he knows of me.

For a matter of sixteen years, I had the privilege of leading an industrial army of from eight to ten or perhaps twelve thousand men. On the matter of hours of labor I have an open mind, as evidenced by the fact that at different times and under differing circumstances we have worked gangs in four shifts of six hours, three shifts of eight hours, and two shifts of eleven and thirteen hours, the reason being that the character of the labour differed. In forging hammered car axles, which is perhaps the hardest and the hottest manual labour that I know of, six hours is about as much as can be successfully worked; and the largest continuous daily output in my experience has been obtained from four shifts working six hours each.

The question of hours depends, in my judgment, largely upon such considerations. Various considerations are involved in this whole question of hours. One of them is: Can we afford it? Mr. Lloyd George, who, as we all know, for many years took a very deep interest in all social questions and matters of this kind, recently made the statement that, as a result of the lessening of the hours of labour within recent years, it had been demonstrated that the output bore an exact mathematical relation to the reduction of hours. He made the statement that a recent analysis of the facts led him to the conclusion that he was wrong in the view that he had formerly taken in regard to the effect of a reduction of hours of work as it affected output.

During the last four years we have had an era of great apparent prosperity in this country—I repeat, apparent prosperity——and we are now face to face with a condition and situation such as we have not experienced in the past. I illustrate that by saying that the cost of all our basic materials has undergone an enormous change. The cost of coal in eastern Cananda, in Nova Scotia, is more than double what it was in pre-war days; the cost of coke has increased 238 per cent; the cost of pig iron has increased 266 per cent; and the cost of producing steel ingots has increased 273 per cent. Now, gentlemen, these are figures that cannot successfully be controverted. I am speaking by the book, and the figures are open to examination; and have indeed been examined by officers appointed by my friend on the platform here (Mr. C. A. Macgrath), who so ably carried on the fuel control of this country in a time when it was a matter of very grave doubt if we should be able to carry on so far as fuel was concerned. As a matter of fact, so high have these costs become that to-day in Cape Breton not a ton of pig iron or of steel ingots is being produced. Why is that? It is because neither the domestic nor any foreign market will pay the cost, to say nothing of any profits to the industry.

We are not in a position either to export that material to the consuming centres of the world or use it in this country, and present costs will have to be reduced before we are able to do so. Now, that is a serious situation. Can we improve it by shortening the hours of labour? I only ask the question.

Another question comes up as to the present efficiency of labour under shorter hours. In certain respects, and in regard to certain kinds of businesses, yes; in regard to others, no. My judgment following an experience extending over a period of 35 years, is this, that 20 years ago, 15 years ago, 25 years ago, so far as ordinary labour was concerned—I am not speaking now of skilled labour, or labour in connection with automatic machinery, but of the ordinary unskilled labour of the country—we were getting from 20 men as much service as we are getting today from 25 or 30 men. That is my deliberate opinion; it is only an opinion; and I may be wrong; for I am often wrong; but in regard to that matter I fancy I am not.

Reference has been made to the results following shorter hours and the possibility in connection with shorter hours in certain industries; and as illustrating that point my friend Colonel Carnegie, has referred to the experience of Sir Robert Hadfield and his firm. Reference has also been made to Ford and some others. Now, I would like to say, so far as the Hadfield firm is concerned, that they had an absolute monopoly protected by patents over a period of years; their product had no competitor; they were able practically to control the whole market in that line. What they really did was not so much to give the shorter hour as to establish piece-work, which in some respects means the same thing. Another gentleman, in the cement trade, referred elsewhere to the fact that he had given his men 9 hours, and he proceeded to say: "What I told them was that if they kept their rock-bin filled I would give them a 9-hour day. What he really did was to put them on piece-work, and if the men had filled their rock-bin in 8 hours of 7 hours, or 6 hours, that was what he wanted. It was piece work, not a 9-hour day. When you get down to the facts your find that Hadfield or Ford or Lord Leverholme, have a monopoly by reason of patents or some secret process, or something else not common to other lines; so that these cases do not apply; that is the point.

With regard to the railway situation, owing to the McAdoo award the increased wages paid on the Canadian National Railway system this year will exceed that paid last year to the same number of men by approximately $20,000,000. If we take the three great railway systems—Canadian National, the Grand Trunk, and the Canadian Pacific—the increased wages paid this year over last year will practically aggregate one hundred millions of dollars, possibly a little more. Where is that spread? We have practically 8,000,000 people in Canada; say 8,200,000, of whom 200,000 are engaged in railway work. The 8,000,000 have to absorb that $100,000,000, which is equivalent to $5 per

month for every family in Canada assuming five people to a family. Now, take the receipts and outgoings of the Canadian National system for the first six months of this year. The gross receipts exceeded those of the same period last year by about $7,500,000; the outgoings, largely labour, amounted to $8,500,000, more than the total receipts. The increased receipts of $7,500,000 were largely made up of increase in freight rates— not in increase in freight carried, for the total tonnage did not increase over that of last year to any appreciable extent. The passenger business increased, because they were carrying to the West a large number of returned soldiers, and as a matter of fact the pleasure travel to-day is greater by far than it ever was before in this country. But, so far as purely mercantile traffic is concerned, there was relatively no increase, though, in fact in one month there was a very decided increase, aggregating over 400,000 tons.

In my opinion an 8-hour day all over Canada for all industry is not now possible. You will ask me what those figures in regard to increased cost of railway operation and other increased costs have to do with the question. They have this to do with it. In view of our present tremendous responsibilities—the great amount of money that has to be raised in this country for not a few years to come—can we afford it? I simply put the question to you. Each of us must answer it as best he can in his own way, in the light of all the information we can obtain, and in fairness to the prosperity and progress of our common country.

POSSIBILITIES OF IRON AND STEEL INDUSTRY IN BRITISH COLUMBIA—LOCAL OPINIONS.

The possibilities of an iron and steel industry being established in British Columbia has been the subject of animated discussion since the publication of the report that large and rich deposits of limonite have been located in the Whitewate River District, some distance from the town of Lillocet, B.C. J. H. Hawthornthwaite, M. P., who is interested in the properties and who made a trip into the Interior to inspect them, goes so far as to say that there are now assured to this Province "blast furnaces, rolling mills and all other necessary accessories to the operation of a great steel plant." Mr. Hawthornthwaite, with whom were competent engineers, gives is as his belief that the region lying between the Klino on the north of the Chilco Lake on the south, a distance of nearly one hundred miles, contains the largest known exposure of iron ore. He says that such a large deposit of high grade iron ore, including hematite, limonite, and ironstone, cannot remain unused for long. Small mountain ranges, he says, can be seen in all directions which are literally clothed with iron from the summits down to far below the timber line. As to transportation he explains that a comparatively short spur line would furnish connection with the Pacific Great Eastern Railway, and thus provide a ready means of access to the coast. While Mr. Hawthornthwaite would like to see the Provincial Government take hold of the property, develop it, and back financially the launching of a steel industry he declares that "no difficulty whatsoever will be experienced in commencing operations at once by the introduction of outside capital. "If the same energy is displayed," continues this member of the Provincial Legislature in prosecuting this enterprise as was expended in carrying on the war it should be possible to have the project well underway within thirty days. Where the rolling mills and subsidiary plants will be placed is, of course, a matter for careful discussion and investigation. But I am of the opinion that there can be no question that Ladysmith offers an ideal location for the establishment of blast furnaces. Two great corporations are engaged in that neighborhood in mining the finest coke producing coal to be found on the Pacific Coast. A coking plant in connection with these mines coud be readily and economically established which, together with the blast furnaces, would provide labor for several thousand men. Thus would a long step be taken towards solving one of the problems that Vancouver Island, as well as the rest of the Province, will have to meet sooner or later.

An iron and steel industry for western Canada has been the theme of the booster for the past two years. The question of market for the product has been overlooked. We all like to see new industries established in our midst, but it is better that an industry should not be established than that it should fail because the opportunity for it is not ripe. As a matter of fact the market is the first essential. This was seen in the case of the plant at Port Moody, where, as soon as war orders for Japan were cancelled, a stock of 600 tons of electric pig accumulated which could not find an opening in the local market. The rolling mills at Medicine Hat, where the natural gas supply affords the most economic field for the industry on the contient, have been closed. The Dominion Iron and Steel Co. has had to close its plant at Sydney, N. S., for an indefinite period for lack of orders. In face of these facts it is premature to establish an iron and steel plant of any magnitude. It is probably too much to hope that raids on the public treasury for visionary promotions and metallurgical dreams will cease till the basic problem of a market has been solved.

"Mining & Engineering Record," Vancouver.

Iron Ore Reserves in the Orient are reported by F. T. Eddingfield, in charge of reports on the iron and steel situation for the Bureau of Mines, according to **Iron Age**, as follows: Toashung mine, containing 20,-000,000 to 30,000,000 tons of ore, supplies the Oriental Ironworks Co. Taiyeh mine, containing about 50,-000,000 tons, supplies the Government Ironworks at Yawata, Japan; also furnaces near the mine supply the Yawata Ironworks with pig iron. At Anshanchan Ironworks of the South Manchuria Railway Co., furnaces are being set up and further enlargements are proposed. Large deposits of iron ore are reported in this neighborhood. Penchihfu Coal and Iron Co. has blast furnaces and electric furnaces. They are reported to have a large supply of coking coal. Chienerhpu Iron Works, Chosen (Korea), operate two blast furnaces.

SHIPBUILDING NOTES.

The Pacific Coast.

At a dinner of the Retail Merchants' Bureau of the Board of Trade of Vancouver, B. C., on September 11, statements were made by Clarence Wallace, of the Wallace Shipyards, Ltd., and Oliver Phillips, representing J. Coughlan & Son, that unless additional government contracts are received at once, steel shipbuilding in that city will be a thing of the past by January of next year. If contracts are available the Vancouver yards will soon be in a position to compete with any shipbuilding firms in Canada, and if the plants can be kept in operation for the next four or five years they will be ready to compete with any shipyard in world.

Construction of twelve more ships in Vancouver yards may result from a conference between Charles J. Fisher, of Seattle, and representatives of local builders. Ships similar to those recently turned out by the Coughlan yards are sought, and the division of the work planned would be equal between the Wallace and the Coughlan yards. The work planned called for ships of the same type as those being turned out at the Coughlan yards. There will be changes in certain details, such as the leaving out of equipment for war purposes. It is planned to begin the work within the next two months, and it is expected that one ship per month should be turned out. Mr. Fisher's contracts would total something like $15,000,000 and would mean increasing the complement of workmen at the local yards to twice the present number. The work would keep the yards busy until the first months of 1921. It is said the Seattle man represents Norwegian interests.

The first steamer to be put into commission on the Pacific Ocean for the Canadian Government merchant marine will be the steamer Canadian Raider, now under construction at the Wallace shipyards in North Vancouver. This vessel is to be berthed in Vancouver about November 15 to take on general cargo for Australia and New Zealand, and is capable of taking 5,100 tons. On her arrival at the Antipodean ports she will be loaded for Vancouver again. This is the first attempt of the government to give Vancouver service both outward and inward by any of the new Canadian boats, and an endeavor is being made to have several other locally-built steamers follow the lead of the Canadian Raider. The other Canadian steamers are being utilized for loading lumber out of Vancouver and the 8,100-ton steamers now under construction at the Coughlan yards at Vancouver will also be used for that purpose, according to present arrangements.

The G. M. Standifer Construction Corporation will start immediately on the construction in its Vancouver yard of five 9,400-ton steel ships. Mr. Standifer states the Shipping Board is offering contracts at figures that no coast yard can accept, and his company is therefore going ahead on ship construction for the open market.

Notice has been given of the incorporation of the Port Alberni Shipbuilding Company Limited, with a capital of one hundred thousand dollars. The registered office is at Port Alberni, B. C.

Liners of the Pacific Mail Steamship Company, the Canadian Pacific Ocean Services, Limited, and the China Mail Company scheduled to sail from Far Eastern ports to America are booked all the way up to January, 1920, and it seems that there are insufficient steamships in this service. It is stated in shipping circles that the Canadian Ocean Services, Limited, are contemplating the shifting of one of their Atlantic liners to the Far East and that the Empress of Canada, which in course of building, will probably be placed on the Far Eastern route.

The Foundation steamer Quebec was launched from the Point Hope Yard, Victoria, B. C., on September 11, Mrs. S. M. Shaw, wife of the general foreman of the yard, acting as sponsor for the vessel. The launching of the Quebec leaves only three ships on the ways, one being at Point Hope and two at Point Ellice. A new construction record was set for the local yards by the construction of the Quebec in less than fifty days.

With the launching of the steamer Wilfrid Laurier by the Foundation Company, at Victoria, B. C., on August 23, 75 per cent of the ships for the French Government have entered the water.

Vancouver, B. C.

It is understood that a plant to manufacture and assemble marine machinery will be located on Burrard Inlet on water frontage adjoining P. Burns' packing plant. Estimated cost, $1,000,000.

Great Lakes and Maritime.

Speaking at a dinner at the Quebec Exhibition given by the Industrial Committee of the Quebec Board of Trade, Hon. Dr. Pelletier, representative of the Province of Quebec in London, touched on the question of winter shipping from the port of Quebec and said that the City of London was prepared to subscribe fifty million dollars to close the Straits of Belle Isle and thus enable the shipping trade in the St. Lawrence to be continued all the year round. Such a project had succeeded at Key West, and why not at Labrador and Newfoundland? The Ottawa and Quebec governments, he said, should unite in bringing this about, and if the scheme was carried out the only cost that shippers would have to bear would be one shilling for every ton of freight that passed the gulf from the month of November to the month of May.

The E. D. Kingsley, a steel boat just completed at the yards of the Canadian Car and Foundry Company, Fort William, Ont., was launched on September 17. The vessel is 1,500 tons deadweight, 209 feet in length, 32 feet beam and 17 feet moulded depth. She was built for the Kingsley Navigation Company, Vancouver, will take grain to Montreal, where she will take on a cargo for Cuba and thence go via Panama Canal to Vancouver. She was built in record time, the keel being laid July 14 last.

The ninth steamer built at the Three Rivers shipyards at Three Rivers, Que., and named "C-9" was launched on Saturday, September 20. The firm has another steamer to build, the tenth of its type, while it has just obtained a contract from a navigation company in France for four large steel vessels.

A strike of short duration took place during September in the shipyard of the Nova Scotia Steel and Coal Company at Trenton, N. S. The men went back on the same terms as they went out on. The two steamers in course of construction are expected to be finished in October or early November. The keel will be laid immediately following launching for a 5,000-ton steel steamer, which will mean continued operations at this yard for at least another year.

The cargo steamer "Alsace" was successfully launched from the shipbuilding yard Canadian Vickers, Ltd., on the 27 September, by Madame Begaud, wife of Captain L. Begaud, the representative of Cie Française d'Armement d'Importation de Nitrate de Soude, of Paris, France, for which company the vessel was built.

The S.S. "Alsace" is a single screw steel cargo vessel of the following dimensions:—

Length between perpendiculars	400 feet.
Breadth moulded	52 "
Depth moulded	31 "

She will have a deadweight cargo carrying capacity of approximately 8,400 tons and a speed of about 11 knots.

She is specially designed for the nitrate trade from Chili to France and is, in all respects, fully up to the requirements of the French Board of Trade and Lloyds 100-A1 classification.

After the launch the "Alsace" was moored to the fitting-out wall of the basin, ready for installation of her engines and boilers.

It is expected that she will be ready for loading in about three or four weeks.

Maritimes Provinces.

At the Halifax Shipyard about a thousand men are now employed between construction work, and shipbuilding.

The keels are laid for two ten-thousand ton steamers, and the work of erecting the frames will commence about the second week in October.

The repairs to the S.S. Lake Manitoba, which it will be remembered was severely damaged by fire are completed. She has been refitted for freight carrying purposes only and will not have passenger accomodation. In repaired condition the vessel will be about 12,000 tons deadweight. She is expected to make her trial trip on the 10th October and to sail for New York about the 12th.

OBITUARY.

Mr. J. C. McGregor of New Glasgow, senior member of J. W. Carmichael & Co, shipowners and builders, died at New Glasgow on September 24th. Mr. McGregor was a director of the Nova Scotia Steel & Coal Company, in the affairs of which Company he had always taken a great interest. J. W. Carmichael & Co. has for many years past taken a leading part in the wooden shipbuilding industry, and as shipowners the firm has a long and honorable record in Nova Scotia.

The Canadian Government Mercantile Marine. — An American Appreciation of Canadian Enterprise.

The Canadian Government has decided to inaugurate an active shipping policy in conjunction with its railroads. Following the lines developed by the Australian, South African and other governments, it will operate freight and passenger ships on all the seas in the interests of Canadian commerce.

The Canadian Government maritime transportation services will be operated by the Canadian National Railway Board. Next month the board expects to place about thirty vessels in commission and new vessels will be added as fast as the builders can deliver them. The initial services will start from Halifax and St. John and will include Newfoundland, Liverpool, Glasgow, London, Avonmouth, Kingston, Havana and other West Indian ports, Buenos Aires and possibly Cape Town.

An Australian and New Zealand service will be run monthly from Vancouver. The Canadian Raider, a 5,100 ton vessel, will shortly be placed on this route. Other vessels for Pacific services to the Orient and India are being built in British Columbia yards and will be commissioned as rapidly as conditions permit. Many of these ships are expected to be on their station before the end of December.

When the scheme is rounded out the Government of Canada will possess vessels making regular commercial voyages on all the important sea routes of the world. They will be operated solely in the interests of the Canadian people and in co-operation with the Canadian Government railroads, consular and commercial intelligence services.

The action of the United States Government in developing an American merchant marine under the auspices of the Shipping Board is being widely followed, for within the next few years it seems probable that the governments of the leading nations will control their whole transportation services, sea as well as land. There is a broad movement to this effect.

Germany did this before the war, and now in addition to the United States, the British, Australian, Canadian, South African, Newfoundland and French Governments, in greater or less degree also shipping and the railways.

Whether this important control movement is destined to eliminate private ownership of shipping and land transportation systems cannot at present be discerned. It probably will not. Government organization and control of national transportation however is certain to prove a powerful incentive to foreign trade expansion and the worst that private shipowners may fear is the regulation of freights and fares. The increased trade which powerful governmental commercial organizations will develop and assist in financing will tend to keep all ships afloat busy.

The new Canadian Government Marine Services are likely soon to indicate the character of the changes that may follow this latest excursion of governments into industries long carried out by private initiative; for this reason, developments will be followed with interest.—"Shipping" New York.

Lloyds will now sanction electric welding practically in the entire construction of a merchant vessel under certain strict regulations, says the London Iron and Coal Trade Review. Ships are now actually being built in which welding is being substituted for riveting, at the Cammell & Laird Co. works at Birkenhead and at Swan, Hunter & Wigham Richardson's on the

Tyne; while at least one large ocean going barge which has been built without rivets is in regular service.

The Admiralty, however, does not consider that the art of welding has yet reached the stage which would justify its adoption in the building of war vessels, although it admits that remarkable achievements have been accomplished in electric welding on some of its own vessels. Thus the main barrel of the cast-steel sternpost of a battleship was found to be cracked right through and, in addition, the starboard flange was badly cracked. In six weeks, notwithstanding a serious delay due to the interruption of the current which necessitated doing a considerable amount of the work twice over, the cracks were all cut out and six cwt. of the new metal welded in, making a perfect repair. The renewal of the sternpost would of course, have been a much longer and more costly undertaking. The cast-steel stern of a P. boat was badly broken but the pieces, five in number, were reassembled, welded together and satisfactorily refitted; while the broken shaft-bracket of a large 36-knot destroyer was repaired by electric welding in a few hours.

An important development of Thermit welding in American shipyards is anticipated by the recent approval by the American Bureau of Shipping of the Thermit process for welding stern frames, rudder frames, and other heavy sections on ships registered under their classification. The only qualification is that this Bureau be notified sufficiently in advance to have a surveyor in attendance during the welding operation as well as to inspect and test the weld when completed.

While the Thermit process has been used since 1903 for making marine repairs and has a great many successful welds of this nature to its credit the process was never officially approved by the American Bureau of Shipping and most of the repairs were made on vessels not classed by them. It is due entirely to the unbroken record of successful marine welds that the Bureau now records its official sanction to the process. According to a statement by the Metal & Thermit Corporation there has never been a single failure of the Thermit marine weld so far as it has been able to ascertain in all the years that the process has been used under this company's jurisdiction.

McGILL UNIVERSITY EXTENSION COURSE IN METALLOGRAPHY.

On or about the first week in October, the Extension Course in Metallography under the auspices of McGill University will be commenced. Last year, this course was very well attended and a great deal of interest shown. It is intended to acquaint the novice in Metallography with the methods of preparing samples of metal for examination and subsequent photography, and to supply the amount of theory necessary to a clear understanding of the results obtained. The fee for the course which consists of 15 lectures, is $20.00 and application should be made direct to the Registrar, McGill University. The number admitted is limited on account of the number of Microscopes available and those wishing to pursue this line of study should apply at once. The class will be conducted as formerly by Harold J. Roast, F.S.C., and C. F. Pascoe.

NEW METAL ALLOY.

During the war an Italian engineer, Adolfo Pouchain, after a series of experiments succeeded in producing a new alloy of zinc and copper, which has been given the name "Biak-metal." This alloy quickly demonstrated its usefulness in Italian industry, and by reason of its special qualities promises to attain similar success throughout the world. Biakmetal has aroused considerable interest in Italy, and I have been told by one of the large manufacturers that his metallurgists have made every effort to determine its exact composition, but without success.

From a small beginning the demand for Biakmetal has increased to such an extent that a new company, the Stabilimenti Biak, S. A., of Turin, having a capital of 12,000,000 lire ($2,316,000), has been formed to carry on its manufacture. The industrial value of a product which is stronger than steel and less corrosive than copper is evident, and it is claimed that Biakmetal, which has passed the experimental stage, possesses these qualities. The most important characterisitcs are stated to be as follows: (1) The highest known breaking point; (2) the highest limit of elasticity; (3) perfect homogeneity; (4) high resistance to thermic action; and (5) high resistance to chemical action.

Strength and Uuses of the Metal.

In the matter of strength, comparisons have been made between different grades of Biakmetal and copper, brass and cannon bronze, which showed interesting results. Among these, tests were made of rods of variods kinds of metal to determine the weight and size required to give a tensile strength of 500 kilos. The results of these tests were as follows (figures in parentheses represent the diameter of the rods tested, in millimeters, and the other figures, the weight of the rods in kilos per linear meter)): Copper (12.6), 1.126; brass (9.5), 0.616; cannon bronze (10.3), 0.723; Biakmetal, No. 3 (6.3), 0.271; Biakmetal No. 6 (8.4), 0.178. (Millimeter, 0.03937 inch; meter, 39.37 inches; and kilo, 2,2046 pounds).

These figures indicate a surprising superiority on the part of Biakmetal. Where Biakmetal No. 3 is used the same strength is obtained with a diameter and a weight considerably less than those of rods of other metals, while with rods of Biakmetal No. 6, of a diameter less than other metallic rods, the weight may be reduced to a small fraction of that of rods of other metals.

Biakmetal is extremely well adapted for almost any kind of manipulation. It can be successfully cast, turned, drawn, forged, rolled and stamped. While its development is still in progress, it has already proved especially useful in aeronautic and marine construction on account of its light weight, its unusual strength and its anticorrosive qualities. In its different forms it may be substituted for steel, brass and aluminum, and for certain uses has important advantages over these metals.

Samples of Biakmetal and descriptive literature relating thereto, published by the manufacturers, may be inspected at the Bureau of Foreign and Domestic Commerce (U.S.) by referring to file No. 40611. The name of the inventor's agent for the purpose of selling patent rights for North and South America may be obtained by referring to the same file number.

Blast Furnace Refractories

(By Raymond M. Howe,* Pittsburgh, Pa.)
Chicago Meeting A.I.M. & M.E., September, 1919

Some time ago, a prominent engineer asked a representative of the firebrick industry to prepare a comprehensive paper on blast-furnace refractories. It was to have been the purpose of this paper to gather practical experiences from widely different sources, in the hope of determining what kind or kinds of firebrick were best adapted for certain uses. This engineer sent questionnaires to the large consumers of blast-furnace linings and stovebrick and received very detailed replies as to their experiences. These replies are conflicting, but, having been turned over to the writer, form the basis of this attempt to meet the request. Because of the impossibility of making final recommendations at this time, a few of the more interesting and commonly known methods of studying refractories are also discussed, as well as the more recent developments in this field.

The first reply to the questionnaire stated that good service was being secured from the linings. This satisfactory condition was attributed to the use of a very good distributor. The writer believed that manufacturers try to and do produce a good product and that the proper handling of equipment is of the utmost importance, if good results are to be secured. The type of bricks used was not mentioned. The second reply stated that good life was secured from the furnace linings, but that the writers had had soft-fired stovebrick crumble and, for that reason, preferred a hard-fired product for use in this position. The type of bricks used was not mentioned. The third reply stated that firebrick had crumbled from the mantle up; the cause was not known. The fourth reply stated that the stove linings were satisfactory. Hand-made furnace linings failed after 4 years' service so a steam-pressed lining was installed which was still good after four years of service. Consequently, a second steam-pressed lining was installed but this disintegrated at the top after the furnace had been in blast 7 months. The firebrick manufacturer attributed this failure to the expansion of iron blocks that had been installed at the stock line to prevent erosion.

The fifth reply stated that the present "hard-burned" hand-made furnace lining had worn away very uniformly to the depth of only 5 in. after 1,042,000 tons of pig iron had been produced. It strongly advocated the use of only the best clay in laying up linings. No stove trouble had been encountered. The sixth reply stated that the writer had secured 16 and 17 years of service from two sets of stoves. At the end of 17 years, one was torn down because of the poor condition of the shell but the checker work was still good. He was forced to reline the combustion chamber from time to time, but hoped to avoid this by washing the gas. He preferred steam-pressed linings to the hand-made, "as the joints are smaller and scaffolds do not get a hold as easily as on the more open joints."

The seventh reply was more comprehensive and instructive. This writer stated that a number of operating and construction factors affect the life and performance of furnace linings, beside the physical and chemical nature of the linings themselves. The most important of these are: Furnace lines, volume

* Senior Fellow on Industrial Fellowship of Refractories Manufacturers' Assn., Mellon Institute of Industrial Research.

Furnace	Blast No.	Days in Blast	Days Operated	Tonnage	Kind of Brick in Lining
2	1	790	744	282,594	Hand-made
2	2	870	870	336,641	Hand-made
2	3	972	972	330,900	Hand-made
2	4	1,607	1,577	628,979	Hand-made
3	1	779	707	252,107	Hand-made
3	2	950	950	365,626	Hand-made
3	3	978	978	351,085	Hand-made
3	4	1,251	1,235	529,316	Steam pressed
4	1	918	904	401,918	Hand-made
4	2	1.664	1,657	823.238	Hand-made

Furnace	Blast No.	Hearth		Bosh		Bosh Angle		Stock Line		Bell		Number of Tuyeres	Kind of top
		Ft.	In.	Ft.	In.	Deg.	Min.	Ft.	In.	Ft.	In.		
2	1	12	6	19	6	72	0	13	6	9	0	12	Handfill
2	2	12	6	20	0	71	20	13	6	9	0	12	Handfill
2	3	12	6	19	6	76	0	13	6	9	0	12	Handfill
2	4	13	6	20	0	74	51	13	6	10	0	12	Handfill
3	1	13	3	20	6	73	18	14	3	10	0	12	Brown
3	2	13	3	20	6	73	18	14	3	10	0	12	Brown
3	3	13	3	20	6	75	0	14	3	10	0	12	Brown
3	4	14	6	21	0	75	25	15	0	10	0	12	Brown
4	1	15	0	22	0	75	0	16	0	11	0	12	Neeland
4	2	16	0	22	0	76	30	16	0	11	9	12	Neeland

TABLE 1.—*Properties of Firebrick*

	Chemical Analysis								Physical Tests					
	Kind of Brick	Loss on Ignition, Per Cent.	SiO_2, Per Cent.	Fe_2O_3, Per Cent.	Al_2O_3, Per Cent.	CaO, Per Cent.	MgO, Per Cent.	K_2O, Per Cent.	Crushing Strength, Lb. per Sq. In. Side	Specific Gravity		Porosity, Per Cent. by Volume	Abrasion 10 Lb. for 10 Min. Applied to End	
										True	App.		Wt., Gr.	Cu. In.
1	Top	0.00	52.84	3.95	41.34	0.12	0.21	1.54	....	2.40	2.06	14.08	31	0.060
2	Top	0.07	54.44	2.53	40.01	0.18	0.53	2.24	5098	2.34	2.03	12.93	62	0.120
3	Inwall	0.08	50.29	3.58	43.14	0.25	0.38	2.37	3910	2.28	2.00	12.29	38	0.075
4	H. & B.	0.07	50.57	3.87	42.73	0.25	0.34	2.17	5153	2.33	1.98	14.92	90	0.180
5	Inwall	0.00	52.36	3.25	42.65	0.09	0.19	1.46	3500	2.33	2.00	14.09	18	0.036
6	H. & B.	0.02	59.83	3.34	34.82	0.15	0.34	1.50	3468	2.38	2.07	12.92	252	0.480
7	Top	0.02	64.01	3.05	30.61	0.12	0.36	1.80	3906	2.32	2.01	13.32	25	0.049
8	Inwall	0.04	53.28	3.51	41.00	0.12	0.25	1.77	3750	2.33	2.04	12.71	185	0.360
9	H. & B.	0.02	53.34	3.51	41.18	0.12	0.26	1.57	2711	2.39	1.97	17.54	74	0.150
10	Top	0.00	57.62	3.60	37.62	0.15	0.16	0.76	5360	2.48	2.12	14.57	19	0.035
11	Inwall	0.01	56.07	3.32	39.00	0.12	0.18	1.30	5248	2.43	2.10	13.30	38	0.072
12	H. & B.	0.15	53.19	3.31	49.91	0.56	0.25	1.59	3923	2.52	2.01	19.97	73	0.140
13	H. & B.	0.14	49.66	2.66	45.66	0.31	0.47	1.10	5110	2.46	2.11	13.91	518	0.97
14	H. & B.	0.21	56.30	3.75	37.21	0.37	0.35	1.81	4230	2.48	2.07	16.42	265	0.57

Furnace Tests					Remarks		
Average Temp.		Maximum Temp., Deg. F.	Expansion in per Linear Feet	Average Permanent Elongation per 9 In.	Surface Fusion	Cracking	Fitting due to Iron Oxide
Deg. F.	Time, Hr.						
2960	4	3011	0.052	0.007	Medium	Very slight	Slight
3016	2½	3157	0 042	0.021	Slight	Very slight	
2960	4	3011	0.042	0.000	Slight	None	
2925	3	2983	0.042	0.042	None	None	Very slight
....	...	3000	0.075	.....	Very slight	None	Slight
....	...	3000	0.064	.....		None	
....	...	3000	0.084	.....	Medium	None	Slight
....	...	3000	0.073	.....	Medium	Slight	Slight
....	...	3000	0.064	.....	Slight	Few and small	None
....	...	2905	0.096	.....	Slight	Many small cracks	Badly pitted
....	...	3000	0.064	.....	Very slight	None	Very slight
2925	3	2983	0.083	0.017	None	None	Slight
....	...	2905	0.136	.....	Very slight	None	Very little
2983	3	3045	0.034	0.070	Slight	Very little	None

of air blown, diameter and lengths of tuyeres, stock line protection, arrangement of gas outlets at furnace top, stock distribution, chemical and physical nature of raw materials, continuity of operation, judgment, knowledge and care by furnace operators. The following data were also given:

He said, "The Brown top on No. 3 furnace during the first three blasts had the original Brown elliptic distributing spout, which had the effect of constantly pitching the stock, so that it was crowded toward the side of the furnace opposite the skip. At the beginning of the fourth blast, the spout was changed to one of V shape, which prevented pitching and effected a wonderful improvement in distribution." He never had brick made to specification but desired a well-burned brick, as pure as possible, made from the proper grinds and mixes to give the necessary physical strength. He prefers a hand-made stove brick to the steam-pressed product, although the latter gives up the heat more rapidly. His preference is due to the fact that his one trial of steam-pressed bricks involved a brick that was too dense so that spalling occurred.

The eight reply stated that the user had used both the hand-made and steam-pressed products of one company, but favored the hand-made, although he had never had any blast-furnace lining failures other than the usual erosion. The stove linings had given satisfaction. Tests that had been made on firebrick were also submitted, these are given in Table 1. The ninth reply said the distribution of the stock is the factor that controls the life of a furnace lining, stating "had the same success been achieved toward better blast-furnace tops and proper lines, as has been reached by the refractory brick manufacturers, there would be less said about poor brick." He stated that his company had increased the tonnage secured from three furnaces by changing lines, but were still having trouble with the linings of the fourth, due to no fault of the refractories.

These nine replies, which represented the opinions of those who used enormous quantities of blast-furnace linings and stove brick, were very encouraging to the manufacturers of refractory materials, who had felt at time that perhaps that industry was not meeting the ever-increasing demands being made upon it as higher temperatures are employed. It is interesting to note that four companies secured good service from their furnace linings but gave no reason; one company attributed its success to the distributor being used; another had figures to show the tonnage secured from each of three furnaces had been increased over [illegible]0 per cent. by bettering furnace lines and control. One reply was less complete but was of the same context. The failures are difficult to explain, for the

crumbling of a top could have been due to one of three causes, the last of which is improbable because of the conditions under which the furnace operates: The action of furnace gases or carbon; the crushing of the bricks; or the loss of bond after repeated heating and cooling. The influence of furnace gases was recently shown very forcibly when iron was removed from optical-glass pots by chlorine or certain of its compounds. These pots lost all of their bond and fell into pieces. The ninth company secured such varying results from different bricks that it would be useless to attempt any explanation.

The service secured from stove brick appeared to be satisfactory in but two cases: one where the hand-made brick were supposedly underfired and the other where the steam-pressed brick were too dense. For the time being these explanations will be accepted.

The writer then visited different plants and learned other facts concerning failures and successes, all of which tend to show that the opinions of operators as well as manufacturers vary. In one case, a record furnace lining had been installed with no little concern, because it was so exceptionally hard-burned. As the lining was needlessly repaired, for the first time, after 1,042,000 tons of pig-iron had been produced, leads one to believe that manufacturers should have no future trouble in disposing of extremely well-burned linings at that plant.

The stove service at the same plant was extremely good, and was attributed to the method of burning the gas. Sufficient air was introduced to burn all the gas in the lower combustion chamber, while other operators allow the gas to burn in the upper combustion chamber and checkers. By following the latter practice, the dust separated out in the relatively cool zone at the bottom of the chamber and, not being fused, was easily removed. Here are two distinct practices. In their adoption it is necessary to consider whether the removal of the dust as dust, or longer service in the top courses of the stoves, is more desirable, for both conditions can hardly exist. At another plant, spalling constantly occurred. The brick proved to be a high-grade soft-clay product. The writer believes that the introduction of grog or flint clay into such bricks, when used in the combustion chamber and the top courses of checkers, would decrease the spalling. The following figures show the effect of the addition of small amounts of flint clay to plastic, the same kind of plastic clay and flint clay being used in each brick.

Experimental Data showing Relative Resistance to Spalling[a]

100 Per Cent. Plastic Clay	90 Per Cent. Plastic Clay 10 Per Cent. Flint	80 Per Cent. Plastic Clay 20 Per Cent. Flint	70 Per Cent. Plastic Clay 30 Per Cent. Flint	60 Per Cent. Plastic Clay 40 Per Cent. Flint
3	4	3[b]	6	22

[a] Relative resistance to spalling. [b] Erratic results.

At another plant furnaces were operating which had given the following tonnages: 720,330, 467,385, 714,114, 937,359, 391,660, 506,403, 669,740, 609,300. The superintendent attributed his success to the fact that he used cooling plates so freely that he was often criticized. By so doing he secured uniform wear at the bosh rather than the uneven wear resulting from alternate hot and cold spots.

Four cases of brick desintegration were mentioned at different plants. In one case the failure occurred about 30 years ago in one of the old-type furnaces. In the second case, trouble began to occur in a very short time with furnace using a high-barium high-sulfur ore, and complete failure resulted in a month. In a third case, a furnace was blown out and appeared to be in good condition; it developed, however, upon following a crack, that the inner 5 in. (12.7 cm.) of lining were good, but that the back portions could be crumbled in the hand. In the fourth case the 13½ in. (34 cm.) brick, upon removal, were found to be split into from four to eight sections. This case is entirely different from the others, for those bricks crumbled into a thousand pieces, while these cracked into several pieces, each of which was strong. At another plant, extreme variations were noticed in a lining that was being installed, for the large blocks varied as much as 1 in. (21.5 cm.) in length and were warped in many cases. Two operators who had experience with such blocks thought that unless the blocks could be made with more uniformity they would revert to the smaller brick for furnace bottoms, although theoretically the larger blocks—because of the fewer joints—are better.

Judging by the success of one plant, which more than doubled its tonnage from each lining, requiring less than twice the time to secure such tonnage, it appears as if there is a reason, other than the linings, why erratic results are secured in other places. This increased production was also one of gradual development, which excludes the elements of chance. However, in order to secure more uniform results, it is essential that the furnace operator has uniform materials with which to begin. Having such, it is more possible to begin real constructive work. It is not the purpose of this paper to tell the steel manufacturers their mistakes or how to control their furnace practice, so it will be restricted to showing what the refractories manufacturers are doing to improve their product and make it as uniform as possible. By following such methods, on both sides, it is quite possible that answers from a questionnaire circulated 10 years from now would be free from contradictory statements and might give sufficient information to make it possible to explain successes and failures in this field.

The manufacturers of firebrick have shown their desire to produce better products from the available raw materials through the action of the Refractories Manufacturers Association. This association is spending annually a considerable sum of money at the Mellon Institute of Industrial Research in supporting a staff of ceramic engineers and chemists, which has increased in number from one to five in less than two years. All of these men devote their full time to the study and improvement of refractory products. In addition, this association has cooperated with the Gas Institute for several years in trying to meet the demands of its members. It has also collaborated with the Bureau of Standards, the Bureau of Mines, and the American Society for Testing Materials in the

development of such tests that will determine the most desirable products for their different uses.

Factors Controlling the Quality of Firebrick.

The more important factors that influence the quality of a firebrick may be conveniently placed into seven groups. The clay is mined by underground or surface methods and is given a preliminary sorting at the mine or quarry. It is then transported to the plant, where it is again sorted as the larger pieces are crushed. After crushing to such size as may be handled by the grinding machinery, the clays are either ground separately and then mixed, or they are mixed and then ground. Both the dry and wet grinding practices are followed. Water is added during the grinding and mixing, the amount depending on the process of manufacture. Then the shaping process follows in which the mix is worked by hand, in a dry press, through a die by different sources of pressure, or in a soft mud machine. After being shaped, the "green" ware is dried in tunnel driers or on hot floors until it is ready to be set in the kiln, burned, sorted, and shipped. The seven steps in the manufacture of firebrick that may affect its quality or appearance and which are being studied by different firms, are as follows: Mining and sorting of clay, grinding, proportioning, tempering, shaping, drying, burning.

Mining and Sorting of Clay.

In order to mine and sort clays on a scientific basis, it is necessary to study each vein the top to the bottom. This is particularly true of plastic clay, which sometimes shows variations in its different layers; yet when these are known they may be located by their color and structure. Accordingly, the practice of sampling clay is gradually increasing, samples being either taken from the operation from day to day or from drill cores obtained years before the clay is used. As a result of such studies, the refractoriness of some brands has been increased by 100°F., while in other cases clay that was not being mined, because of a peculiar color or structure, has proved to be superior to the run-of-mine product. These statements are not meant to imply that all plastic clays vary or that all plastic clays are carefully picked; some plastic clays are remarkably uniform and hence offer no problem, in others, a poor spot may occur in the center of the vein and cannot be entirely removed. Under such conditions the clay can only be carefully mixed into a uniform blend of slightly lower refractoriness, thus avoiding a particularly bad lot. Fusion tests generally give sufficient information as to the uniformity of a deposit. There are times, however, when a particularly siliceous or aluminous brick is desired and this necessitates chemical analyses.

Grinding.

The influence of grinding on the product is rather well known, in general, the finer grinds result in the production of a dense firebrick while the coarser grinds produce one that is more open and porous. However, as in the case of concrete, the strongest block is not secured from the sand nor from the gravel, but by having the proper proportions of the different sized material. Fortunately, flint clay or grog assumes different sizes in grinding and a suitable blend is secured without great difficulty. As a precaution, however, some plants screen their grog to different sizes before incorporating it into the mix. The effect of grinding is also modified in the process of manufacture.

Proportioning.

Proportioning is a problem that each plant must work out for itself as each plastic clay varies, in that some will bind considerable grog or flint while others will not. Some plastic clays are very nearly as refractory as the materials they bind, while others are of lower refractoriness. Obviously, the permissible amounts of two such clays would not be the same. Another problem that confronts only the producer lies in the relative amounts of plastic flint clay and grog that are available, for he must proportion them in such a way that the maximum return is secured, unless he supplies some of particular trade for which a certain definite type of firebrick is required.

Notwithstanding the fact that 100 per cent. flint-clay bricks are sometimes made, the strength of a brick varies directly with the bonding clay, for the strength of all-flint bricks may be increased by the addition of plastic clay. A direct application of this principle lies in the manufacture of blast-furnace bricks, where the refractory requirements diminish and the strength requirements increase from the hearth to the top.

Tempering.

The characteristics of a firebrick depend very largely on the amount of water used in its manufacture. The full plasticity of a clay is not developed unless sufficient water is added; and, conversely, the plasticity may be decreased by diminishing the amount of water used in its tempering. The proper amount of water that should be used in making the densest or most porous brick varies, not only with each individual mix but with each process of manufacture. The following figures, selected from several sets of data, illustrate clearly how, in general, the strength of each mix increases with the amount of water until a limit is reached, after which the further addition of water results in a slight falling off in mechanical strength.

Per Cen. Water by Weight	Modulus of Rupture of Burned Piece	Porosity of Burned Piece
7.5	2491	24.0
9.0	6019	20.3
10.0	4020	20.6
Another Mixture of the same clays		
7.5	1891	23.35
9.0	5675	21.45
10.0	4670	21.50

Shaping.

Regarding this step, from the standpoint of firebrick structure only, the most dense product should result from clays worked at stiff mud consistency, providing the necessary pressure is applied. Furthermore, a dry-pressed or hand-made brick must be fired to a higher temperature in order to secure the same effect. By the same reasoning one would hardly choose the stiff-mud process for making an open firebrick.

Drying.

Although this part of firebrick manufacture is a study in itself, it is of no particular interest to the consumer. It is true that cracks sometimes develop during the drying of large shapes, and these are often objectionable. It is also true that the color of firebrick is influenced by the water that remains in the

brick as they are placed in the kiln, for the combination of sulfur from the coal and steam tend to bring the iron to the surface, giving rise to a pink discoloration. Advantage is taken of this fact in some localities, where it is necessary to set facebrick when they are quite "green," to obtain a sufficiently deep color. Tests have shown, however, that the pink-colored firebrick are often of the same refractoriness as the lighter products made from the same clays, although this color may be an indication of excessive impurities.

Its full strength can be gained and its contraction removed with no difficulty.

On the other hand, a plastic clay of type E must be burned to a higher temperature in order to remove its shrinkage, for such a clay continues to contract with increasing temperatures until the period of expansion resulting from overburning begins. A clay of type D is not at all uncommon. These plastic clays aways retain their open structure and are not adapted to the manufacture of dense, abrasion-resisting bricks.

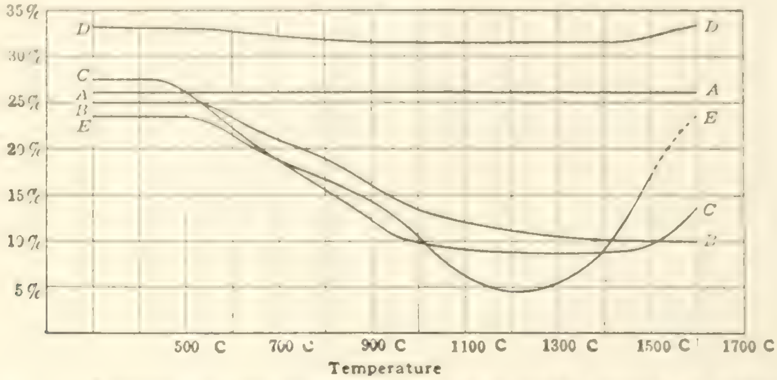


FIG. 1.—POROSITY OF GROUND FIRE CLAY PIECES WHEN BURNED AT DIFFERENT TEMPERATURES. *A*, OPEN-BURNING FLINT CLAY; *B*, DENSE-BURNING FLINT CLAY; *C*, HIGH-GRADE DENSE-BURNING PLASTIC CLAY; *D*, HIGH-GRADE OPEN-BURNING PLASTIC CLAY; *E*, LOW-GRADE DENSE-BURNING PLASTIC CLAY.

Burning.

Burning is of prime importance to the consumer, who sometimes prefers a light-burned product, while in other instances he wishes one of a very hard burn. The writer does not feel that rule-of-thumb reasoning should be applied to this requirement and submits the curves given in Fig. 1 to show the effect of heat on different flint and plastic clays. To the manufacturer such curves are important in that they show which clays can be most successfully used in making dense or open firebrick for different purposes; and, while they cannot be expected to be made available to the different consumers, they do indicate what can be expected of the firebricks made from such clays when placed in service. They also act as a guide to the manufacturer in establishing his burning practice, for hardly any two clays require the same treatment in this respect.

When it is borne in mind that clays contract as their porosity decreases, during burning, the following deductions can be quickly and accurately drawn. A flint clay that has a burning behavior similar to A need not be burned to a very high temperature in order to make a high-grade product. Its volume remains practically the same and when the bonding clay is mature few, if any, benefits are gained by harder burning. Such a clay is undoubtedly responsible for the statement that certain bricks expand in service and hence give very good service in roofs. As a matter of fact, they can hardly expand more than usual but they do not contract.

A flint clay of type B, on the other hand, must be burned in the kiln to a high temperature if shrinkage during service is undesirable. The same statements also hold true in a slightly different way for plastic clays. For example, a plastic clay of type C becomes dense at a low temperature and then remains very much the same over a wide range of temperature.

Additional curves could be shown, but these are sufficient to show that all firebricks cannot, or should not, be burned in the same way. They also show how hopeless a task it is to apply any one set of clays to all kinds of service.

Installation.

Were it not for the interest that the manufacturer of refractories must keep in his product until it is torn out, as a success or failure, his responsibility would cease at the plant. It happens, however, that furnace practice and conditions vary so tremendously that repeated failures force him to "see" his product through to the end. A good many failures are simply accepted as such and are not investigated at all, others only superficially, and others are too complicated for solution. A few failures that have come to the writer's attention, and are not the manufacturer's fault, are briefly described here.

1. A high-grade firebrick fusing at a temperature exceeding 3100°F. (1700°C.) was laid up in a local loam that fused in the vicinity of 2100°F. (1148°C.). Parallel cases concern very cheap unsorted fireclay.

2. A similar firebrick was laid up with thick joints of a patent cement intended for another purpose but, due to the salesman's ignorance or overconfidence, was tried although it was not sufficiently refractory (fusion point 2300°F.—1260°C.) for that purpose.

3. A firebrick used in a furnace roof gave two weeks' service where six weeks' service was generally secured. Investigation of plant record showed that the coal at that time was extremely high in sulfur and afforded a very corrosive ash, which, when deposited on the roof, formed a slag that ate the brick. Tests made on the good ends of the failure proved the firebrick to be of the usual standard of refractoriness.

4. Lime came into contact with a fireclay brick, several of which in the hot zone reacted with the lime to form a glass. Investigation of the ends proved the firebrick to be of the same quality of refractoriness that had previously given satisfaction. As there was

no method for measuring temperature at this plant, the natural assumption was that the heat had become excessive and caused the usual reaction between fireclay and lime or magnesite. Lime is sometimes added to fireclay in order to secure a firm joint; it is difficult to understand why this is done, when manufacturers spend thousands of dollars each year to eliminate high-lime clays and secure those that are low in lime and other similar fluxes.

5. Stove bricks failed, due to a crumbling of the upper courses. The original bricks were of high refractoriness, but tests showed that a very corrosive dust had been deposited which lowered their refractoriness from about 3150°F. to 2400°F. Undoubtedly this dust, as it became heated and cooled or liquid and solid, exerted considerable disintegrating force. It is quite possible that one of the failures mentioned in the questionnaire replies was due to similar conditions.

6. Checker brick were reported as failures. Investigations showed that the bricklayer did not like their color, though fusion tests showed that they were of exactly the same refractoriness as the ones considered satisfactory. The tests also showed that a slag was deposited upon the surface of these bricks, which lowered their softening point of 3175° F. (1747° C.) on the inside of the brick to 2540°F. (1394° C.) on the exposed surface; also that the brick that had been condemned was more dense and, hence, more resistant to slag penetration.

At numerous plants, failures have occurred when sand, ashes, and other forms of insulation have been used. It must be remembered that radiation is often the one factor that saves a firebrick from quick failure. In removing this protection one should proceed with care, the factor of safety is being decreased and the firebrick is being subjected to more severe conditions, which may result in failure. On the other hand, roofs sometimes "creep" or sag when made of inferior material that has been too lightly burned. Excessive erosion occurs when a firebrick is not sufficiently strong mechanically to resist this influence. Poorly molded, irregular blocks are also encountered.

It is very rare that a brick melts out unless it is contaminated with furnace dust or slag. Many experiences like the preceding could be mentioned were it necessary, but the one important lesson they teach is that they are costly and do not always give definite information. In order to avoid needless repetition, the manufacturer must know what kind of a product he is producing and the consumer must be thoroughly familiar with his working conditions. The manufacturer is trying to do his part and the consumer must do the same, for he will benefit the most. He must insist on the construction of furnaces according to blueprints and on the careful selection of mortar. He should also know what kind of brick are being installed, not only as to brand but as to burn, process of manufacture, and general characteristics. He should also be able to show temperature and tonnage records for different furnaces and the nature of the fuel or slag, or both, that is coming in contact with the firebrick.

These statements do not apply only to blast-furnace linings and stoves, for being major installations they are watched more carefully. The following figures given before the Federal Trade Commission, show that but a small percentage of the production of firebrick is used in such installations and, hence, if complete records are to be secured they should apply to the other positions. If better records are kept and the causes of failure are noted, there is no reason why many consumers cannot secure the 100 per cent. better service secured at the one plant previously mentioned.

Consumption of Firebrick in Different Industries.

	Per Cent.
Beehives and long coke ovens	0.4
Blast furnaces	5.0
Boilers and stokers	4.0
By-product coke ovens	11.0
Cement plants	1.0
Copper brass, lead, and zinc	2.0
Crucible furnaces	1.0
Cupolas and foundries	1.0
Dealers	2.0
Rolling-mill furnaces	7.0
Piping	4.0
Gas plants	4.0
Glass plants	1.0
Lime plants	2.0
Malleable furnaces	4.0
Miscellaneous furnaces	2.0
Open-hearth plants	41.0
Kilns	4.0
Railroad trade	7.0

The manufacturer of firebrick, on the other hand, will be better able to make a product that is best suited for each installation or to state that his product does not meet the necessary requirements. If repeated failures occur at some plants, all parties concerned will be in a better position to know the cause or causes. The Refractories Manufacturers' Association has already had some very pleasant experiences, especially in cooperation with the Gas Institute. Should blast-furnace operators feel the need for similar collaboration, this association is not only willing, but is anxious, to join in such a movement.

REFRACTORIES.

At the recent Philadelphia Meeting of the American Chemical Society, a symposium was held on refractories, from which the following notes are selected:

Work of the Technical Department of the Refractories Manufacturers' Association.—R. M. Howe.—During May, 1917, the Manufacturers' Association established a fellowship at the University of Pittsburgh for research work on refractories. A laboratory was equipped and tests commenced on fire brick. Since that time the personel has increased from one to five investigators and over 50 companies have been served. The organization is self-supporting and its mode of operation is such as to prevent a monopoly of the service by any one company. Some tests have been made on magnesite and silica.

The work has embraced mining selections by drill cores, analyses of same, together with investigations of mixtures and blends made up of brick bats, bauxite, silica, etc. Among other factors considered were temperature operation, water content, abrasive qualities and physical strength. It was found that an increase of water content increased the strength of the brick. Method of manufacture and drying depends on type of clay as regards its contraction characteristics. Performance of brick under service is also a part of the work.

The Selection of Refractories for Industrial Furnaces.—W. F. Rochow. The chemical composition of

a refractory material is not so important as heretofore considered, especially in many cases where the temperature, is not of sufficient height to reach the point required for chemical reaction between the walls of the furnace and the material being treated. It is often better to use an acid brick with a basic material, or vice versa. An example of this is the use of silica brick in the glass industry.

Silica brick is found to be 25 per cent better than fire clay for by-product coke oven due to its high thermal conductivity, mechanical strength and high fusing point. A more uniform temperature is secured in muffles due to the high thermal conductivity. Thermal expansion of silica brick occurs between 230 and 500 deg. C. and the heat must be carefully applied through this range. It is practically eliminated after the first burning. The mechanical strength is good at high temperature. In arch construction it is insulated with kieselguhr. Long service of a brick in open-hearth furnaces shows four distinct strata with the lime stratum carried to the center of the brick and away from the heat.

Magnesite brick is not strong at high temperatures, and in order to remedy this feature a soft steel band or casing is built around blocks of dead burned magnesite for such work as gas ovens.

Interesting Facts Concerning Refractories in the Iron and Steel Industry.—C. E. Nesbitt and M. L. Bell. Refractories are an important factor in the successful operations of the iron and steel industries. Good results will obtain if the producer of brick co-operates with the consumer, for the latter should know what the product must stand and the manufacturer must know the limitations of his product.

The range of temperature in the iron furnace varies from 260 deg. C. at the top to 1600 deg. C. at the tuyères. The chemical and physical properties should be known. Test conditions must be more severe than operating demands. Questions are raised by the tests given through the American Society of Testing Materials such as why the life of the same type of brick varies from 2 to 7 years or why converter bottoms last from two to six heats, and some of the individual bricks stand intact in these bottoms, while others are destroyed.

Simple tests should be evolved for use of the consumer so that quantity runs could be made. It has been evidenced, with a variation in temperature from 30 to 1350 deg. C. that the crushing strength is reduced 60 per cent, and that loss in open-hearth roofs have been 20 per cent with 261 heats due to fire cracks. The variation in chemical composition occurs when fumes penetrate the pores in open-hearth work. The method of manufacture has a pronounced effect on the qualities of clay brick.

Maurice Casenave, Minister Plenipotentiary and Director-General of French Public Service, in address at Lafayette celebration at Milwaukee, says production of pig iron in France will soon reach 9,600,000 tons a year, of which 1,500,000 tons will be exported, and production of steel will equal 7,500,000 tons, with 1,000,000 tons for export. He states these facts to show how France is pushing its reconstruction activities.

BOOK REVIEW.

The Iron Hunter, by Chase S. Osborn. MacMillan Company, New York. Cloth 5½" by 8", 316 pp., illus.

This is an unusual book, and after reading it one realises that its author must be an unusual man. The book is actually an autobiography, of the kind that might be expected from a man who made his way by personal endeavour from a penniless condition to Governor of Michigan and a candidate for President of the United States. Mr. Osborn, writes: "For forty "years now I have lived in the robust north, and in "Winter I have taken a run naked and rolled in the "snow every morning before breakfast, when in the "woods, say at four o'clock. In all that time I have "known of only one young man who would follow "my example, without being ridiculed into it or compelled in some way." One can quite credit the statement.

The author claims to have visited virtually every accessible iron-ore deposit in the world, and his travels include a journey by reindeer sled across Lapland, in February, and trips to Madgascar, Africa, Burma, Ceylon, Cochin-China, Turkestan, and Persia, all connected with the hunt for iron-ore that Mr. Osborn conceived as his life work. An interesting reference to Madagascar contains an intimation that the author is aware of the location there of a vast deposit of iron ore containing metallic iron of 64 per cent and nine-thousandths of one per cent of phosporous..

But the most interesting references to Canadian readers in this kaleidoscopic recital are in connection with the north shore of Lake Superior, and Mr. Osborn is unstinted in his praise of the open spaces and clean wildernesses of our Canadian Northland. "North of "us lies the vastest unexplored territory in the world. "I refer to the Dominion of Canada. It is rich, and "where it is untouched by man, it is clean. There "is not a drop of unwholesome water nor any poisonous insects nor reptiles between Lake Superior and "the aurora borealis." Mr. Osborn has the blood of the prospector in his veins, for he remarks: "I think "the greatest charm of prospecting is not the hope "of finding wealth, it is the life in the clean unhurt "out-of-doors." Describing the north shore of Lake Superior he writes: "Olivines and epidotes make "floors of verde antique, and pegmatite shows red as "blood above and also below the waters." His description of the berries and natural beauties of this region are reminiscent of the writings of another poet turned geologist who has described Northern Cape Breton in the Geological Survey Reports of 1873, the late Hugh Fletcher.

A pleasing, and not overdrawn reference is to the work done in connection with the geology of iron ores in the Lake Superior country. "Such distingushed names as Douglas, Houghton, Brooks and Pumpelly, Charles Wright, Irving, Smythe, Lane, Winchell, Chamberlain, Seaman, Van Hise, Leith, Hotchkiss, Merriam, Allen, Coleman, Miller and others are "familiar to those who are interested. At a time when "most of these men could have turned their knowledge "into money they have been ethical to an extent "that is praiseworthy. I do not know of one of these "who took advantage of his chance to make a profit; "not a single quack among them." And so say we all.

A further statement regarding the administration of Canadian mining law is interesting, coming from a man who is above all a typical citizen of the United States.

"I had heard" writes Mr. Osborn, "that nothing "could be obtained from the Government departments "at Toronto without paying for it; that from top to "bottom there had to be bribery. I saw nothing of "the kind during years of experience, and I do not "believe a word of it. The fees of Hearst and McKay "were reasonable, and they told me they never thought "of paying any "grease" money or permitting graft."

Our author tells of a "starvation hike" to an "iron dam" on the Vermillion River, of camping in such primeval wilderness that a bull moose walked over him while asleep, and winds up his chapter by stating:

"Where I slept in the little open shed tent, and was "unawakened by the moose that nearby stepped on "me, there is now a flourishing mining town reached "by a branch of a transcontinental railway. They "did not develop there without much hard and en- "joyable work." This refers presumably to Moose Mountain.

An anecdote of "Dan Mann" tells amusingly how the Canadian railwayman was challenged to a duel by a Russian count in China, and exercised the privilege of the challenged to choose the weapons by selecting double-bitted axes, to the use of which the Russian, our author suggests wisely, demurred and the duel was off.

The book contains a full technical description of the mining and roasting of siderite at the Magpie and Helen Mines, and makes the observation that in this instance an elaborate and relatively costly mining and roasting system enriches from 30 to 50 per cent, an ore never before used in America, and it is done profitably. Reference is made to the astonishingly cheap and plentiful occurrence of iron-ore in the United States, and its effect on the relative value of lean ores. Our author pertinently remarks: "What are regarded "in the United States as lean ores are esteemed of "great value in other iron-making countries." Reference is made to an experimental plant at Duluth where Hayden Stone & Company enrich magnetic ores containing thirty per cent of metal to 62½ per cent by electrical treatment, which method alone, the author suggests "will make it possible to utilize the millions upon millions of tons of lean magnetite that belts Lake Superior like a containing encasement."

Mr. Osborn's unusual cast of mind is evidenced in his suggestion that a new and permanent standard for money could be found on the basis of calories. Gold, Mr. Osborn, contends, is not really a norm of permanent value, and the calorie does supply the markets and finances of the world with such a norm. Such a solution of the problem of coinage value fluctuation would not occur to the ordinary person. Mr. Osborn is evidently not an ordinary person, and his book is extraordinary, but well worth reading.

THE APPLICATION OF PULVERISED COAL IN BLAST FURNACES.

The Canadian Mining Institute Bulletin for July contained a description of the progress made in using pulverised coal in blast furnaces which made the following references to the smelting of iron:

History of Early Attempts.

"The use of pulverised coal in reverberatory furnaces, cement kilns, open hearth furnaces, boilers and other similar furnaces, has been dealt with extensively in many papers and publications; the present paper on the other hand will be confined to the application of pulverised fuel to blast furnaces, wherein the mixture of fuel and air is injected into the lower portion of a piled mass of material, and combustion takes place under pressure.

Until recently the history of pulverised coal in blast furnaces contained nothing but records of failures. Sir Lowthian Bell, in his book on the "Principles of the Manufacture of Iron and Steel" published in 1872, which deservedly ranks among the world's metallurgical classics, mentions an attempt to introduce finely divided coal with the blast at the tuyeres in an iron furnace; the attempt was soon abandoned, and Bell remarked that it needded but little consideration to insure rejection of all such schemes.

About 1902, Mr. W. J. Forster of Darlaston, England, satisfied himself by a great number of experiments at the Darlaston furnaces: "That nothing but failure can be expected from the addition of cold materials into the hearth of the furnace with the blast."

Possessed of this opinion, Mr. Forster suggested the use in the blast furnace of a specially prepared carbon obtained by heating solid carbon to a very high temperature, so that all volatile matter and moisture should be expelled and the carbon should be strongly heated before its use in the blast. He obtained British and American patents on the expedient of so preparing carbon and introducing it with the blast, whereby he hoped to make special grades of iron. The idea seems to have produced no effect upon the art of smelting iron, but it may be considered to illustrate the rest of the history of the use of pulverised fuel in blast furnaces as this history consists of sundry comparable suggestions of expedients all of which have, so far as known, failed to meet with practical success. The efforts to use successfully pulverised fuel in iron blast furnaces have embraced such expedients as the substitution of heated gas, with and without superheated steam, for some or all of the air; the careful classifying of the fuel into different and distinct sizes with a view to employing the finer grade to create a high initial temperature to ignite the rest; the substitution of an annular reverberatory arranged around the base of the charge, and the injection tangentially thereinto of the powdered coal and air; the grinding and mining of the charge itself so that the particles might fall through a stream of burning fuel and air, and so on. It is not profitable for present purposes to consider all these expedients or the various patents which have been granted on them, because, so far as is known, none of them has been sufficiently successful to secure adoption.

The results obtained by the recent work which we shall now describe have been attained not so much by resort of extraneous expedients as by the development of the combustion process itself. The chemical phenomena of combustion are relatively little known, although they have been made the subject of important research work by numerous scientists since the days of Bunsen, who, in 1845, made investigations on a coal-fired blast furnace used for the smelting of iron ores; and it is impracticable, within the limits of this paper, to discuss these phenomena in detail. The phenomena apparently embrace distillation of volatile matter, gasification, and combustion. When a mixture of air and finely divided fuel is directed into and

against a mass of more or less refractory material, different results may ensue, according to variations in a multiplicity of factors. The work to be described seems to demonstrate that by proper provision of suitable space for combustion, maintenance of correct air pressure and fuel within the combustion space, it is practicable to develop within the charge a sort of supercombustion, which provides at greatly reduced cost the heat necessary to bring the charge to a molten condition. It is particularly difficult to generalise or define the possibilities or limitations of the generation of heat in a blast furnace so operated, for much depends upon the physical and chemical characteristics of the charge, as well as upon the variable factors directly entering into the combustion."

The authors suggest that a better idea of the work can be obtained by concrete illustration, and proceed to describe in great detail the experiments of Mr. Garred in a field which, the authors believe has heretofore been untouched even by suggestion, namely, the melting of copper and the smelting of copper ores.

At the plant of the International Nickel Company the most recent work has been to operate the furnace entirely without coke, following earlier work where an average of fifty per cent of the coke had been replaced. The results, with all coke eliminated, are sufficiently encouraging to continue the experimentation with this object in view.

The processes involving the application of pulverised fuel to blast furnaces have been patented in the United States, Canada, and many foreign countries; the patentees, Garred and Cavers, both being engaged in work connected with the smelting of nonferrous ores, and both were simultaneously working on practically the same problem, of the combustion of finely divided fuel in a blast furnace. Owing to the magnitude of the problems involved, a consolidation of their interests was effected recently, by the formation of the Garred-Cavers Corporation, New York, which company has acquired the patents issued and pending in connection with this work. It is expected that experiments on the smelting of silver-lead ores will be commenced in the near future, and there is every reason to believe the prospects are good for increasing the efficiency of blast furnace practice.

During the last few years, some twenty to thirty million tons of non-ferrous ores per year have been treated in blast furnaces in the United States, Canada and Mexico, and it is believed that further developments of a satisfactory nature in connection with this work will enable a large proportion of these ores to be smelted with considerable economies in fuel.

The Garred-Cavers Corporation has made contracts and issued licenses for the use of its process by the International Nickel Company of Canada, the Tennessee Copper Company and Cerro de Pasco Copper Corporation. Mr. W. J. Hamilton is Consulting Engineer to the Cerro de Pasco Company and arrangements have been made to utilize pulverised coal in the existing blast furnaces at the smelter, but also in a new smelter to be constructed by that Company.

While the application of pulverised coal, in its present development, does not extend to the smelting of iron in the blast furnace, it does not appear unreasonable to expect that the lessons learned from its use in non-ferrous smelting may lead to a wider application that may some day include the reduction of iron ores.

COMPANY NOTES.

An amalgamation has been made by the Collingwood, Ont. steel plant and the Canadian Western Steel Co., Ltd., with rolling mills at two Western points. The new concern has been incorporated under the name of the Canadian Western Steel Corporation, Limited, and it proposes to start work at the now idle rolling mills at Collingwood, and also to start up the open hearth furnaces. Construction will begin within a few weeks. The corporation will have in operation at an early date three rolling mills, located at Collingwood, Ont., Medicine Hat and Redcliffe, Alta., also a bolt and nut plant at Medicine Hat, Alta., which will enable it to supply the trade both in eastern and Western Canada.

The International Abrasive Corporation is making application for listing on the Boston Stock Exchange.

This consolidation is of interest to Canadian readers as it is comprised of the Superior Corundum Wheel Company, Dominion Abrasive Wheel Company, Harrison Supply Company, and National Abrasive Company with plants at Waltham, Mass., Amesbury, Mass., Niagara Falls, Ont., and Mimico, Ont. Three of these companies are successfully established. The National Abrasive Company is a new producer.

It is stated the new Company will be the only producer of "Natite", said to be the most successful of manufactured corundums, and it is claimed that a ton of this patented product can be produced for $14.25 against $30 per ton of corundum by the ordinary bauxite process.

The situation of the plants of the Company in both Canada and the United States is expected to give maximum tariff advantages.

Put in Furnaces.—The Volta Manufacturing Company, Welland, have installed an electric furnace for the Walker Metal Products Company, Walkerville.

The Gales Refractories, Limited, of Montreal East, are just completing a 60-ton kiln for the making of fire brick. It is expected that two others of similar capacity will be in operation before the close of the year.

The Percival Plow and Stove Company, Limited, Merrickville, Ont., is negotiating with the Town Council for property on which to build a new molding shop and machine shop.

W. H. Cooper, Clyde Building, Hamilton, Ont., has been awarded general contract for the erection of an addition to the plant of the Frost Steel and Wire Co., Sherman Street North, to cost $27,500. Gordon J. Hutton, Bank of Hamilton Building, is the architect. Sub-contracts will be let.

W. H. Cooper, Clyde Building, Hamilton, Ont., has been awarded the general contract for the erection of an addition to the plant of the Dominion Sheet Metal Co., Ltd., 322 Burlington Street, to cost $23,000.

Contracts for the erection of five factories to cost $22,000 have been awarded by the Montreal Locomotive Works, Ltd., 145 St. James Street. The buildings are to be erected as an addition to the company's plant at Longue Pointe, Que.

The Tavani Electric Steel Company, Belleville, Ont., are contemplating construction of a steel and iron foundry in Winnipeg. Estimated cost, $5,000,000.

Lake Superior Power Corporation are contemplating additions to hydro-electric power-plant to supply the Algoma Steel Company with additional power in case the Algoma people proceed with present plans for extensions to the steel plant.

The ratepayers of Brockville, Ont., have voted a free site for proposed factory of Brockville Paper Manufacturing Co., and construction of factory will proceed immediately.

The International Plow Company at Hamilton, Ont., are constructing additions to building. Estimated cost, $200,000.

Dominion Canners are to erect a modern plant in the industrial section near the Hamilton Bridge Co., at an estimated cost of $[illegible]

Sherbrooke, P. Q.—Among the contracts recentl yreceived by the MacKinnon Steel Co., Ltd., are the following: Structural steelwork for Belding Paul Corticelli Building, St. John's, P.Q., general contractor, Anglins, Norcross, Ltd., Montreal: steelwork for St. Augustine's Church, Cote St. Antoine Rd., Montreal. general contractor, M. J. Stack; steelwork for extension to Dominion Tire Factory, Kitchener, Ont., general contractor, Atlas Construction Co., Montreal; superstructure for 200-ft. span bridge to be erected on the East Branch of the River Yamaska; superstructure for 215-ft. span bridge to be erected over the Riviere Noire, municipality of St. Valerien, Shefford Co., P. Q. This company are also fabricating steelwork in connection with an extension to their own office, for which the general contractor is the Sherbrooke Construction Company.

TRADE OPENINGS

The Weekly Bulletin of the Department of Trade and Commerce lists the following enquiries for Canadian iron and steel and associated products.

London firm, open to purchase molybdenum, invites offers from actual Canadian producers.

Vladivostok firms enquire for wood-cutting machinery, metal-cutting lathes, agricultural implements, motors, belting and all electrical supplies. Another Vladivostok enquiry is complete equipment of workshops with turning, polishing and grinding tools and lathes, and machine tool accessories.

Liverpool (Eng.) firm asks for lathes from 3½″ centres up.

Asia Minor stated to be a promising field for tractors and all kinds of agricultural implements. Greek Government making similar enquiries.

Liverpool firm ask to be put in touch with manufacturers of country-house lighting sets.

Another Liverpool firm ask for particulars of oil engines.

Australian firm asks for names of Canadian manufacturers of bronze powder, aluminum and tinfoil.

Australian trade organization asks among other things, for particulars of Canadian ability to supply agricultural implements, automobiles, gas and oil engines, fencing and other wire, fertilizers, field cultivators, nails, pumps and tools.

Sheffield (Eng.) firm asks for quotations on cobalt, nickel and ferro-alloys.

Newfoundland importer asks for quotations on Canadian shovels.

Hardware importers in Cape Town, South Africa ask for Canadian quotations on nails, bolts, nuts, rivets, tacks, box strapping, baling wire, hoop iron, horse-shoes and horseshoe nails, tinplate and tinman's solder.

Importer in Port of Spain, Trinidad, asks for Canadian quotations on a mill for crushing and pulverising limestone for fertilizer.

North of Ireland firm enquires for Canadian maker of tinned mattress wire.

TRADE INCORPORATIONS.

The International Bushings, Limited, is granted Dominion incorporation with a capital of $25,000,000, head office Toronto with a comprehensive charter to manufacture and deal in metals.

Alliance Steamship Company, Limited. Incorporators: Frederick Henry Markey, Waldo Whittier Skinner and George Gordon Hyde, K. Cs; John Gerard Ahern, advocate; and Robert John Forster, secretary—all of Monteral. Capital $1,000,000, divided into 10,000 shares of $100 each. Chief place of business, Montreal.

Acadia Stationery Engines, Limited. Capital $200,000. Registered office, Bridgewater.

Province Elevator Company, Limited. Incorporators: Benjamin Cronyn Parker, Charles Alan Crawley and Bert Vershoyle, barristers-at-law, Samuel Wallace, accountant, and Harold Leslie Marchant, student-at-law—all of Winnipeg. Capital $500,000, divided into 5,000 shares of $100. each. Chief place of business, Winnipeg.

Western Steel Products, Limited. Capital $100,000. Registered office, Vancouver.

The Belt Grip Pulley Company of Canada, Limited, has been incorporated to carry on business as manufacturers of all kinds of pulleys and wheels. The capital stock is $200,000, divided into 20,000 shares of $10 each, the head office being in Toronto.

F. F. Fry, Limited, have been incorporated under the Ontario Companies Act, to carry on a general contracting and engineering business. The capital will be $40,000 in 400 shares of $100 each, the head office being in Toronto.

The National Metal and Waste, Limited, has been incorporated to carry on a general business as dealers in old materials. The capital stock is $40,000 divided into 400 shares of $100 each, and head office in Woodstock.

Paxton-Mitchell, Limited, is incorporated with capital stock of $100,000, head office Montreal, as a private company to deal in iron, steel and metals, and general machinery.

M. E. Casey Co., Limited, is incorporated as a private company, capital $50,000, head office Monteral, to do business as mechanical engineers.

Houlding & Walker, Limited, is incorporated, with head office at Brantford, Ont., capital of $100,000, to manufacture and deal in automobiles.

The Colonial Machinery Co., Limited, Cowansville, Que., has been incorporated with a capital stock of $50,000 by Harry R. Fraser, Frederick S. Rugg, Charles de L. Mignault and others, all of Sherbrooke, Que., to manufacture machinery, tools, implements, etc.

The King Separator Works, Limited, Bridgeburg, Ont., has been incorporated with a capital stock of $50,000 by Edward H. Neelon, George F. Peterson, Frank N. Rutherford and others, all of St. Catharines, Ont., to manufacture cream separators, implements, machinery, boilers, etc.

The Charles A. Strelinger Co. of Canada, Limited, Windso Ont., has been incorporated with a capital stock of $100,000 by Charles A. Strelinger, Charles T. Bush, Charles E. Allinger and others, all of Detroit, Mich., to manufacture machinery, tools, automobile parts, etc.

The Buchanan-Duncan Motors, Limited, Toronto, has been incorporated with a copital stock of $40,000 by John Jennings, 67 Yonge Street; James Buchanan, George H. Lovatt and others to manufacture motor cars, tools, engines, etc.

The Glo Products, Limited, Toronto has been incorporated with a capital stock of $100,000 by Ira Marks, 351 Markham Street; Wilton Marks, 438 Lansdowne Avenue; James R. Curry and others to manufacture machinery, tools, implements. etc.

The Canadian Auto Accessories Co., Limited, Ottawa, Ont., has been incorporated with a capital stock of $40,000 by Frederick E. Heney, Thomas E. Powers, Frederick C. Wright and others to manufacture automobile parts, accessories, motors, etc.

The Union Cap Screw Co., Ltd., Walkerville, Ont., has been incorporated with a capital stock of $100,000 by James G. Bass, Windsor, Ont.; Olin M. Whitman, Alexander E. Whitman and others, of Detroit, Mich., to manufacture screws, screw machines, tools, etc.

The Security Auto Theft Signal Co. of Canada, Limited, Dunnville, Ont., has been incorporated with a capital stock of $100,000 by George H. Orme, William O. Smith, Adolphus W. Haun and others to manufacture iron, steel and brass. products, safety devices, etc.

The Dominion Dehydrator Company, Limited is incorporated under Ontario charter with head office at Toronto, capital $150,000 to manufacture and deal in de-hydrating machinery and to carry on the business of de-hydration of vegetables, etc.

Synthetic Rubber and Tire Co. of Canada, Limited, is granted Ontario charter to deal in automobile tires and [illegible] in and manufacture rubber and rubber substitutes. Capital $150,000, head office Toronto.

Burns Hardware, Limited, is granted incorporation in Ontario to engage in a general hardware business. Capital $100,000, head office Toronto.

Steel Burial Vaults, Limited, is incorporated under Ontario [illegible] with capital of $100,000, head office Toronto, to [illegible] and manufacture burial vaults and metal coffins.

The War Was Won. We Must Help To Win The Peace.

During the war Canadians as a whole, devoted their every effort to the successful prosecution of it, all classes and creeds were as unity in conscientious service. Capital invested in enterprises whose life could be expected to end with the cessation of hostilities; labor gave of its best, clerical staffs worked short-handed and with inadequate salaries, and the young men of the courtry gave their life's blood—all in order that the greatest good might come to the greatest number.

The great success of Canadian armies; financial aims, and manufactures, affords the greatest possible example of the value of unity of purpose.

With the signing of the armistice, however, this bond was apparently ruptured with the result that the country seems divided into factions all pulling in different directions.

We Canadians have a task before us the magnitude of which is hardly comprehended by the majority. The National debt has hardly received the serious attention of the people. This question is of the most vital importance; large revenues must be raised for regular maintenance charges, interest on the debt; pensions for disabled returned men, and the provision of sinking funds.

Just how these revenues and monies are to be raised, must be given out by the government shortly.

The labor situation is critical and must be handled firmly and honestly, labor must realize of its own volition the vicious results of further wage increases and be prepared to give an honest day's work for an honest day's pay.

Capital cannot, reasonably expect to make the same percentage of profit as was possible under pre-war conditions and must be prepared to share with labor a portion of the difference. Neither should any obstacle be thrown in the way of Capital which will prevent its seeking investment in new enterprises. Some extra compensation must be allowed for the risk entailed.

It cannot be possible that the lesson learned during the war, can be so soon forgotten.

A true sense of duty; a proper idea of service, and cooperation of all peoples, will be of the same importance, and have the same result whether the country be at peace or war.

Canadian bore a proud part during the war. We feel confident that they will take an equally proud position in peace.

The Electric Furnace Company, Alliance, Ohio, just installed nine new Baily Electric Furnaces for melting a wide range of non-ferrous metal and alloys.

The Drew Electric & Mfg. Company, Cleveland, Ohio, has purchased a 105 K.W. furnace, of 1,500 pound capacity for melting yellow brass.

The Kennedy Valve Company, Elmira, New York has installed a 105 K.W. electric furnace for red brass.

The American Bronze Corporation, New York City has contracted for two 1,000 pound electric furnaces for melting bronze.

The Dominion Steel Products Company of Brantford, Ontario, Canada, has installed a 50 K.W. furnace of 500 pound capacity for yellow brass.

The Deming Company, Salem, Ohio, will melt yellow and red brass in a furnace of 500 pound capacity.

The Miller Pasteurizing Machine Company, Canton, Ohio, will use its Baily 50 K.W. furnace for yellow brass.

Landers, Frary & Clark, of New Britain, Connecticut, will melt aluminum in a 50 K.W. furnace that has a capacity for 200 pounds of aluminum per hour.

PERSONALS.

Mr. D. H. McDougall, President of the Nova Scotia Steel and Coal Company, accompanied by Mr. Galen Stone of Hayden & Company., Boston, are expected to leave for Europe on the 7th October by the "Empress of France" from Quebec. These gentlemen expect to visit iron and steel centres in Britain, France, Italy, Spain and Roumania, and also anticipate visiting the iron mines of Norway and Sweden.

SCOTIA RESUMES STEEL MANUFACTURE.

The Nova Scotia Steel & Coal Company resumed steel manufacture on October 1st, running two open-hearth furnaces on cold metal. Work on the blast furnace is being pushed with three shifts of men on eight hours, and it is hoped to have the furnace ready to be put on blast by the 1st of November. During the period of suspension the Scotia plant has undergone a complete and thorough overhauling, including the re-lining of No. 1 Blast Furnace, extensive repairs to the open-hearth furnaces, and repairs and re-fitting of the machinery.

F. W. GRAY.
Editor, Iron & Steel.

NEWFOUNDLAND NEEDS A GOVERNMENT GEOLOGIST.

Since the death of Mr Howley, the Government of Newfoundland has not appointed a successor in the appointment as Government Geologist which Mr Howley held for many years.

This strikes us as a regretable omission. If any country needs a competent geologist it is the newly created Dominion of Newfoundland. The agricultural wealth of Newfoundland can never occupy the status it does in countries with longer hours of sunshine and feder pre-Cambrian exposures. Newfoundland is known to contain asbestos, chrome, iron, in tremendous quantity; some coal, copper, limestone, lead, and many other minerals, but the country has never been thoroughly geologically surveyed and mapped. The task of doing this would be a difficult and expensive one, but it would be well worth while.

A country that posses what is probably the most important hematite ore reserve in the north temperate zone is justified in employing the very best geologist obtainable. It is difficult to over-estimate the value of the Wabana iron ore deposit to the British Empire. The quality of the ore, its geographical location, its ownership by one of the associated British peoples as sturdy and valiant as Newfoundland has prove ditself to be; the apparently illimitable quantity of ore present, and the lessening quantity of iron ore in the known reserves of North America, all go to make the Wabana deposit enormously important. The most authoritative report on the Wabana deposit was compiled under the direction and at the expense of the Canadian Department of Mines. The information contained in that Report was considered to be necessary to Canada. How much more does Newfoundland need such information for herself. A gouvernment geologist in Newfoundland is nos a luxury, but a business necessity.—Canadian Mining Journal.

The Volta Manufacturing Company, of Welland, Ontario, who are manufacturers of electric furnaces of all types and sizes, as well as automatic regulators for electric furnaces, electric winches, hand controllers, magnetic brakes and all electric furnace accessories, have recently supplied Hiram Walker & Sons, Metal Products, Limited, Walkerville, Ont., with the complete equipment for a one-ton capacity electric furnace of the tilting type.

The Hiram Walker & Sons Metal Products, Limited, have been operating this furnace for several weeks and are producing a very high grade of cast iron, nichroloy and monel metal.

Inasumch as this furnace equipment is a Canadian manufactured product throughout it will be interesting to the electric world to know that it is being operated by a growing Canadian industry, and, with the increased electric energy that will be available in the near future, due to the Hydro Electric Power Commission's developments, it is to be expected that many of these electric furnaces will be installed throughout Ontario, as well as the other Provinces, during the next few years to take care of the growing demand for electric furnace products. As a matter of fact, the manufacturers of this furnace are now receiving numerous inquiries from manufacturers who propose installing electric furnaces of various capacities in the near future.

EDITORIAL

By-Product Coke Ovens in Canada

In this issue will be found a description of the by-product coke-oven plant of the Algoma Steel Corporation, at Sault Ste. Marie, by William Seymour, Superintendent of the Coke Oven Department. In the December issue will be published an account of the new Koppers by-product coke-oven plant of the Dominion Steel Corporation, at Sydney, Nova Scotia, which will also be written by the Superintendent of that Corporation's coke-oven department, Mr. C. E. Wallins.

"Iron and Steel" is further promised an authoritative description of the new Wilputte by-product coke ovens of the Steel Company of Canada, at Hamilton Ont.

We desire to acknowledge the courtesy of the foregoing steel companies for permission to obtain these first-hand descriptions, and to thank the superintending officials who have been good enough to write the articles, and have thereby enabled this periodical to present to its readers a correct and full account of the three by-product coke-oven installations connected with steel-making in Canada.

We also publish a description of the new by-product ovens of the Granby Consolidated Mining & Smelting Company at Anyox, British Columbia, together with a brief review of the associated mining operations at the Hidden Creek Mines and at the new Cassidy Colliery. While these ovens are not connected with steel-manufacture, they are interesting as being designed to make coke for smelting operations, and as being the first by-product ovens to be built on the Pacific Coast. If those who favour the commencement of a blast-furnace industry in British Columbia should proceed with plans which are as yet only in the first stages of discussion of possibility, these oven will have a direct interest to the steel industry, and will afford, through their operation, exact data on the costs and yields of coke manufacture and by-product recovery from British Columbia coals. Such data is of course infinitely superior to laboratory data, as in actual practice no person can say just how a given coal will wash or coke, or what analysis of coke will be obtained in practice, until actual full scale experiments have been made, and until these experiments have been prolonged for some time.

A striking similarity of all the coke-oven plants in Canada is that they are either quite new, or the older installations have been repaired and improved. At no time was the equipment and the technique of coke manufacture in Canada in better condition than they are in today. The beehive type of coke-oven is now counted obsolete, as it should be, and in the by-product installations the tendency is ever towards more complete extraction and utilisation of the by-products. The time is rapidly approaching when the consumption of coal for creating heat or raising power, in the natural state in which it is mined, will be as obsolete as the beehive oven, and for the same reasons, namely wastefulness, dirtiness and general inefficiency.

Workmen's Compensation Laws

One of the matters in which complete concurrence of opinion was obtained at the Industrial Conference in Ottawa was regarding the necessity for tne standardization of workmen's compensation laws in Canada.

The essential fairness of compensation for injuries sustained during the course of employment is not today a matter for dispute. It may be regarded as generally accepted.

There are two main divisions of administration of a compensation law. The first is based on the original British enactment, which provides for the payment of compensation for injuries received and for fatal accidents, where dependents are left, but leaves the payment of compensation to be arranged between the employer and the employee, with recourse to the courts in case of disagreement. This method of administration usually carries with it lump sum payments of compensation.

The second mode of administration is vested in a commission, which has absolute power to determine the

compensation payable, under the prescription of the act, and permits no recourse to the courts. Administration by a state commission usually includes collective assessment of industries by groups, the rate being at the discretion of the Commission, and monthly payments and pensions in lieu of lump sum payment.

Administration by a state board has the following features to recommend it. It entirely eliminates recourse to the courts and avoids the necessity for the employment of lawyers. No direct contact between the employer and the employee is required, and no questions requiring agreement or disagreement between them are raised. Medical diagnosis of injuries rests with the medical officers of the state board, and in this regard a fruitful field of non-agreement is avoided. Monthly payments of compensation for injury correspond approximately with the periodical receipt of earnings, and avoids all the abuses and disasters that accompany lump payments of compensation. The payment of comparatively large sums of money to persons unable to expend it wisely has nothing to recommend it, and much to condemn it.

The administration of a compensation law by a state board is a logical evolution from the acceptance of the principle that compensation for occupational injury is a charge against the industry as a whole. The evils of bureaucratic control are admitted and well-known, but if we accept the foregoing postulate, there is no other way by which industry, as a whole, can be fairly and equitably assessed for compensation for injuries received in industry.

From the employers' side, we believe there is much to be said for the manner in which workmen's compensation is assessed and disbursed in Ontario, Nova Scotia and British Columbia. The method of group and collective assessment, after some years of experience, enables the cost of compensation to be assessed upon the payrolls with precision, and within a limited range, and in this way, employers are relieved from the uncertainty of judicial decisions, and the necessity for legal consultation and payments. In the objections which accompany the working of a compensation law such as is in force in the Province of Quebec, employers should not fail to reckon the time spent by executives in contesting conpensation cases.

The Report of the Ontario Compensation Board for 1918 contains the following:

"Complaint is made by some members of the legal "profession that they are ruled out of practice in con- "nection with claims under the Workmen's Compen- "sation Act. The Board feels that this is in accor- "dance with the spirit and intention of the Act."

In the Quebec Court of Appeal, during the sitting of the 28th October, Mr. Justice Martin, in rendering judgment in a compensation case, called attention to the fact that it had taken nine judges, nine doctors and four lawyers nearly four years to determine the nature and extent of the respondent workmen's injuries. His Lordship remarked that he quite appreciated that it was the function of a judge to interpret the law as he found it, and perhaps he ought not to suggest any changes or reforms in the law as made. "But, in the light of the facts I have mentioned." said Justice Martin, "I feel safe in asserting that if a Commissioner was to administer this Act with the assistance of an independent medical board, he would have settled and determined the whole matter in dispute between the parties in three hours."

Lawyers as a class would be the last to suggest that statutes should be framed to give them the maximum employment, and the moral pointed by these parallel statements requires no elaboration.

Not only does administration by a Workmen's Compensation Board provide impartial handling, but it leads to expeditious and skilful handling. The administrative and medical officers of a Compensation Board, handling many thousands of cases in a year, become as impersonal, as correct, and as skilful in their work as fallible men can hope to become.

No cheaper or more equitable form of administration is possible. As the 1917 Ontario Report puts it: "Practically all the money contributed by employers goes to workmen or their dependents as compensation. The administrative body has no motive to give the workmen less than he is entitled to, and no motive to charge the employer more than he should pay."

From the workmen's point of view, there is no convincing reason that can be given to him why he should receive differing treatment in regard to compensation for injury, according as he may be injured on this or that side of a provincial boundary.

From the employer's viewpoint, it should not be forgotten that such compensation statutes as exist in Ontario, Nova Scotia, British Columbia and Alberta, take away from the workmen all common law rights by virtue of the privileges conferred in the compensation acts of those provinces. Common law liability is an uncertain and erratic one, and in some industries—most industries in fact—the menace of common law liability, as interpreted by a jury, is not to be preferred to an all-inclusive payroll assessment for compensation purposes, administered by a skilful and neutral state board which eliminates every unnecessary expenditure in administration, and avoids all issues of possible disagreement with injured workmen, or their dependents.

There is another point. Employers are human, and oftener than may be admitted by some pehaps, are humane, and the contesting of a compensation case is in many instances a distasteful business that most executives would be glad to be relieved of.

Some Considerations on Monopolies

In recent years there has been much antagonism towards large consolidations of capital, or so-called "big business". It may be proper to enquire whether control of production of a given commodity to the point of monopoly is inherently vicious and against the public interest.

In considering the size of any given enterprise, it is necessary to take into account, in making comparisons, the extent of the natural resources and wealth of the country in which the enterprise is situated. In illustration, newspaper reports from England tell of the "most important combination of coal-mines and steel mills since the beginning of the war. Its capital will be $30,000,000 and it will control coal production of 5,000,000 tons annually." Really there is nothing extraordinary about this, and in United States financial circles such a merging of interests would evoke but languid comment. Making due allowance for the relatively smaller natural resources of so small an Island as Great Britain when compared with trans-Atlantic wealth and acreages, it indicates that very little consolidation of coal and steel interests has taken pace in Britain when such unusual importance is attached to a small consolidation.

We may therefore ask what has been the result of such free and independent operation of coal properties in Britain? The gravest indictment in the Sankey Report, and perhaps the only indictment in which the other Reports concurred, was the judgment that the inefficient working of British collieries—insofar as it was admitted—arose from conflict of unconsolidated interests and lack of co-ordination in the winning of given coal areas.

The proposals put forward by the British Cabinet to improve coal production in Britain outlines precisely the policy that would be followed if all the coal-mines of Britain were under the control of one privately owned corporation.

Two facts seem to have been made clear by the events of the war as they have affected Britain and the United States. First, that efficient production and economical operation can only reach a maximum under unified control. Second, that such unified control by a popularly elected government, if at all prolonged, leads to all the abuses of patronage, nepotism, laissez faire, and the corruption of the electorate that has accompanied government control of industry wherever it has been tried.

The conclusion these two factors would appear to lead to is that the most efficient operation of industry is attained by a unified control under private management, having for its object the obtaining of commercial profits, and, it logically follows, that the more complete the control and the nearer it approaches monopoly, the more economical and efficient will be the operation of the industry. This conclusion seems inescapable, and before the war it had been demonstrated by the operation of the Standard oil business and the evolution of the United States Steel Corporation.

It does not therefore appear that there is any good reason for objecting to large consolidations of capital as such. Wherein then exists the popular fear of capitalistic monopoly? In the belief that its resources have been used to subvert the processes of legislation, or, to phrase it differently, that large accumulations of wealth, or widely extended control of wealth, constituted a menace to the State.

A similar demonstration of the power that lies in unified control has been given by the growth of labour unions. A larger and still larger measure of control over the members of a given craft is sought by labour leaders, and they are not satisfied with anything less than monopoly of such control, which they designate as the "closed shop".

The O. B. U. has striven to express the completest evolution of the idea that has yet appeared in Canadian life, whilst those co-partners in criminal dreams, Lenine and Trotzky, have visions of the dominance of the proletariat which they have translated into a veritable heirarchy of hell.

The old-fashioned notion of none for a party but all for the State has been literally shot to pieces. The world seems to be endeavouring to express the sentiment of the Welshman: "It iss efery man for myself".

Various interests in the modern world seem to watch for opportunities to take the public by the throat, and by their control of public utilities and the necessities of daily life, seek to gain personal ends and the separate interest of a craft, by strike ultimatums at selected periods of public necessity, seeking political dominance by such methods, or—as they term it—by direct action in preference to the legitimate use of the vote.

The newest example of this spirit is the strike threat of the United Mine Workers of America, who have proposed revolutionary changes in hours of work, and blandly insist that no decrease in production and no increase in price of coal will result therefrom; and with equal blandness explain that if a strike occurs it will be because the operators did not accept their conditions. That the strike ultimatum is dated for November first, when coal has become a necessity for life, with the alternative of death to many if production ceases, is a point that is not enlarged upon by the miners' leaders.

The truth is that many organizations today have conceived that they are bigger than the State, and they deliberately have set to work to sap the foundations of

the commonweal to gain separate and selfish aims, forgetting, or careless, of the interdependent nature of the social fabric, and the danger of a catastrophe that shall overwhelm all in common ruin.

There are signs of hopefulness abroad, however. The collapse of the police strikes in Britain and in the United States, the cold crack which the British public gave the railwaymen recently, the failure of the O. B. U. in Winnipeg, the sense of impending calamity which has moderated the utterances of some of the more thoughtful and outstanding leaders of labour, and President Wilson's plain statement to the leaders of the U. M. W. of America that they contemplate treason against the public interest, are all matters of encouragement to those who believe that political ends should be gained by the vote, by the accepted and orderly processes of democratic government, and not by ultimatums issued by the General Staff of a craft, timed and designed to carry effective threat by inflicting the maximum hardship upon a long-suffering and harassed public, already exploited to the point of desperation.

Monopoly is effective, appallingly so, but if civilization is to survvive, the supremacy of the common weal of all the people, expressed through the executive officers of the State, must be upheld and defended against all assaults, whether of Capital or Labour. Just now, Labour, or its representatives—which is not at all the same thing—is guilty of precisely those sins that it has laid to the account of unbridled capitalistic individualism.

The Experimental Brick Plant of the Nova Scotia Steel and Coal Company, Sydney Mines

In the June number of "Iron & Steel of Canada" we ventured a belief that the steel industry of Canada cannot be regarded as self-supporting until a much greater development of native ores, coal deposits and and local sources of refractory materials has taken place than is now the case, and announced the desire of this paper to give publicity and aid to all that goes to render Canadian iron and steel industry self-contained and nationally independent. We asked for contributions descriptive of all such efforts, no matter how small or apparently trifling, because we believe, and may be permitted to re-state this belief, "that the significance of endeavour does not reside altogether in its magnitude."

In this connection, and in this spirit, "Iron & Steel" is pleased to be able to include in this issue an account of the experimental brick-plant at Sydney Mines, which has been successful to the extent of relieving the management of the Nova Scotia Steel Company of anxiety as to receipt of certain classes of firebrick from outside sources, and has demonstrated the possibilities of local sources of refractory clays.

Canada, because of the erosive action of the continental glaciation which the country has so generally undergone, is relatively poor in such residual materials as clays, and only occasional deposits of these materials are found, except where they occur associated with the coal measures. The Coxheath deposit referred to in Mr. Dawe's article is an example of an occurrence of relatively pure and high-grade refractory clay, preserved by the conservation of the surrounding rocks from complete erosion by glacial action. There are, however, fairly large deposits of shales and clays in Nova Scotia associated with the coal seams, which include fireclays of medium refractory qualities, but so little attempt has so far been made to utilise these clays that it would be premature to express the opinion that really high-class refractory materials were not present in Nova Scotia.

One occurrence of a medium refractory clay is being worked by the Intercolonial Coal Company of Westville, Nova Scotia, and we hope in a later issue to include a description of this established industry. Another occurrence of similar nature is found as associated with the coal-seams in Inveness Co., Nova Scotia, but it has not been developed as yet.

In Sheffield district of England, some excellent refractory materials are found in the Lower Coal Measures, and the general characteristics of the Nova Scotia Coal Measures are so reminiscent of the Yorkshire coal deposits and associated shales, as to suggest the possibility of similar deposits of 'ganister' and siliceous shales in the as yet unexplored lower coal occurrences in Nova Scotia.

A similar experiment in regard to local manufacture of firebrick has been carried out by the Dominion Iron & Steel Co. and we hope also to give our readers a description of this in a later issue. Our readers would be of mutual service if they would send for publication accounts of local attempts to relieve Canada, to such extent as may prove possible, of dependence on outside sources of refractories in connection with the steel industry, and the associated coke-oven industry.

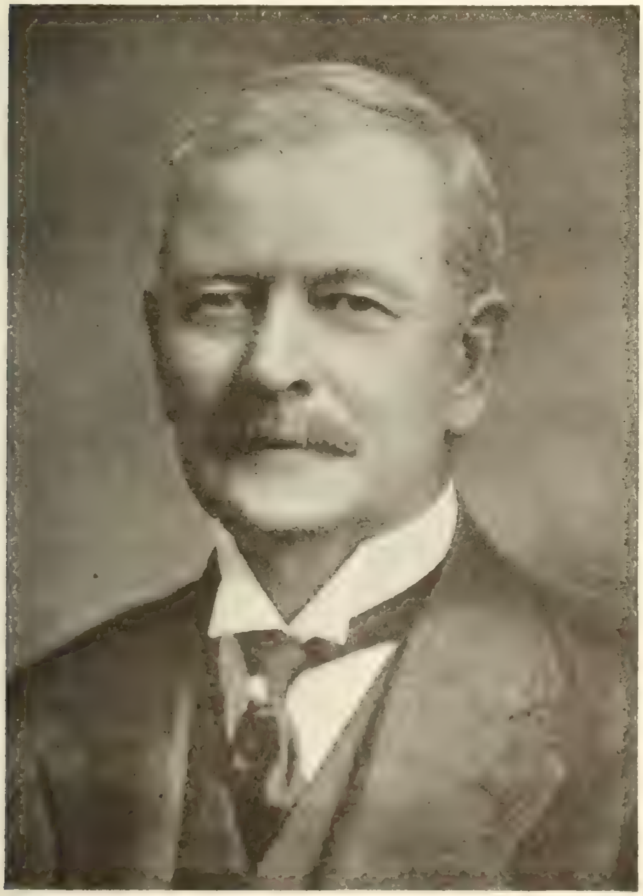
RETIREMENT OF Mr. M. J. BUTLER.

M. J. Butler, managing director of Armstrong & Whitworth of Canada, Montreal, has retired from active work, and is now living in Oakville, Ont.

Mr. Butler was deputy minister and chief engineer of the Department of Railways & Canals from 1905 to 1910, when he resigned to become second vice-President & General Manager of the Dominion Steel Corporation, at the time when Dominion Steel interests obtained control of the majority stock of the Dominion Coal Company, and combined the administration of the two companies under Mr. J. H. Plummer as President.

In 1912, Mr. Butler left Nova Scotia to organize a Canadian branch of Armstrong Whitworth & Co., and his term of administration has covered the valuable service rendered by this concern during the war period, as the Longeuil Plant was only opened for work in December 1914.

During Mr. Butler's incumbency he has not only superintended the initial details of commencing a new industry in Canada, but has during this period been responsible for some entirely novel and notable additions to Canadian practice in the iron and steel industry, including the successful manufacture of high-speed tool-steel, the manufacture of rolled-steel railway tires, and the application of powdered coal as a fuel in the heating processes of the specialised steel products of which



M. J. BUTLER, C.M.G.

Armstrong Whitworth & Co. has been pioneers in Canada.

Mr. Butler was made a C.M.G. for his services in the Department of Railways & Canals, and is also a doctor of laws, which is not an honorary title merely, as Mr. Butler was called to the Illinois Bar in 1897, or nineteen years after he had been in practice as an engineer.

Mr. Butler's record of hard work during the early years of Armstrong Whitworth & Co. has only been possible by careful conservation of his physical energy. Mr. Butler is still a comparatively young man, but his contribution to Canadian progress has been a strenuous and a notable one, and his retirement is well earned.

NOTES.

The "Canadian Foundryman" for October contains an unsigned article on the "Mineral Resources of North Hastings, Ont." written from the standpoint of a foundryman and making interesting observations on the deposits of talc, iron-ore and graphite found in this part of Ontario. While the observations made are not in all particulars correct, one pertinent remark is worth quoting. "My object in writing this article is because "of the persistent habit Canadians have of boosting "foreign made goods. Even Germany could teach us "something on this score. When a German made a "mouth-organ or a dolll, or any trivial thing, he was "proud to stamp it 'Made in Germany', but we prefer "to speak of New Jersey fire-brick, Georgia soap-"stone and Ceylon plumbago, instead of Canadian "fire-brick, Canadian soapstone and Canadian plum-"bago."

The illogicality of some phases of trades union thought is well illustrated by the proposal of a delegate to the meeting of the British Miners Federation held in London late in October. This delegate advocated an ultimatum from the Trades Union Congress threatening a stoppage of production if prices were not reduced fifty per cent within three months.

What good would it do to explain to this delegate that the most far-reaching of price advances arises from the increased cost of coal, consequent upon increased wages and decreased hours of labour, and that this basic advance is doubled, trebled and everlastingly pyramided as it enters into the successive stages of manufacture of commodities of general use, all of which are based as to costs upon the power derived from coal?

OBITUARY.

Frank J. Lyman, managing director of the Lyman Tube & Supply Co., Ltd., Montreal, died suddenly two weeks ago at the age of 42. He was the founder of the business, which was the successor to the railway department of John Millen & Son, Ltd., Montreal, which he managed for 10 years prior to the establishment of the Lyman Tube & Supply Co., Ltd.

The By-Product Coke Plant of the Algoma Steel Corporation at Sault Ste. Marie, Ont.

By Wm. Seymour.

The Steel Plant at the Soo which is now part of the Algoma Steel Corporation was erected in 1900. It was not until 1910 that it was deemed advisable to build coke ovens, the coke used previous to that time being obtained from bee-hive ovens in the States.

The original installation, consisting of two batteries of Koppers regenerative by-product ovens of 55 ovens each together with the necessary coal handling and by-product recovery apparatus, was completed early in 1911 and put into operation in March of that year.

The location of the plant on St. Mary's River, which is the connecting link between Lake Huron and Lake Superior, makes the use of water transportation of considerable advantage.

All the coal is brought from Lake Erie ports to the Soo by boat and therefore sufficient storage capacity is necessary to stock five and one half months' supply for coke oven and steel plant consumption during the closed season of navigation.

The coal used is procured from the Company's mines in West Virginia; Cannelton from Kanawha and Fayette counties and Pocahontas from McDowell county. They have the following typical analyses:

	Moisture	Volatile	Fixed Carbon	Ash	Sulphur	Phos.
Cannelton	3.11	36.22	55.71	8.07	1.21	.0137
Pocahontas	2.61	18.97	73.03	8.00	1.14	.0123

The coal is shipped by rail to Toledo or Sandusky, and loaded into freighters of from 8,000 to 11,000 tons capacity which comes to the Soo by way of Lake Erie, Detroit River, St. Clair River, Lake Huron and St. Mary's River. Upon arriving it is unloaded by three Heyl & Patterson towers then transferred from these to the storage by transfer cars running on an elevated track which traverses the full length of the storage in such a position as to divide it so that the necessary amount of Cannelton may be stored on one side and the Pocahontas on the other. These transfer cars are equipped with doors operated by compressed air, so that the coal may be dumped on either side. The coal is dumped on the proper side and then stocked by a Heyl & Patterson bridge of the man trolley type.

The coal unloading towers have a record of unloading a boat containing 10,995 tons of coal in an elapsed time of twenty-one hours; an actual working time of eighteen hours.

The original storage was 300 ft. wide and 1,280 feet long and had a capacity of 162,000 tons Cannelton and and 108,000 tons Pocahontas when stocked to the maximum height of forty feet.

The coal storage, however, has been at times a source of trouble. Every Winter there has been considerable heating and during some Winters serious fires have developed. By careful attention to the coal in storage, cross cutting the pile as soon as possible after the close of navigation, and using as much as possible of the overheated coal for general use about the plant rather than for making coke much of the trouble was avoided. Also, experience with other piles has shown that this coal can be piled to a depth of 30 feet without heating and plans are now being made to extend the storage space so that the 40 ft. storage piles will be eliminated. This heating has a very marked effect upon the quality of the coke. The shatter test may drop as much as 15%. More coke per ton iron is used at the blast furnaces, the burden has to be lightened and the blast pressure goes up. In addition to the effect on the coke, the yields of tar, ammonia and light oil drop and more B. T. U.'s are required to coke one pound of coal.

At a point on the elevated track near the middle of the storage is the receiving hopper for loading the coal for the ovens. The coal may be dumped directly into

Coal Unloading Towers.

this hopper by the transfer car as it comes from the boat or it may be recovered from stock by the bridge, put into the transfer car and carried to the hopper. From this receiving hopper, the coal is fed, by a steel pan feed belt, onto a thirty inch belt conveyor which carries it up to the Bradford breaker located at one edge of the pile.

The Bradford breaker breaks up the coal so that all will pass through a two inch round hole and removes any large pieces of foreign material. From the breaker the coal is taken up to the mixer bins by a twenty-six inch conveyor. These are of 100 tons capacity each, one for Cannelton and one for Pocahontas. Under each bin is a steel pan feeder belt and the mixer is controlled by gates which regulate the depth of coal on the belt. The coal from these belts goes into a common chute equipped with a mixing device and thence, by a divided chute into two crushers. There are two Williams hammer crushers which crush the coal so that 70% will pass through a $1/8''$ mesh screen. From the crushers the coal is taken up to the 2000 ton

* Coke Oven Superintendent, Algoma Steel Corporation, Sault Ste. Marie, Ont.

storage bin over the batteries by a third belt conveyor. The capacity of the coal handling is 200 tons per hour.

Each of the two Koppers batteries consists of fifty five cross regenerative ovens. The dimensions of each chamber are: width, pusher side 17 inches, coke side 21 inches; length 39 feet, heighth to bottom of leveller door 8 ft. 6 in. Each oven having a rated capacity of 12.75 net tons of coal. The walls between ovens are divided into thirty vertical flues so arranged that seventeen are on the pusher side and thirteen on the coke side. The vertical flues are connected by a horizontal flue located near the top of the oven chamber and each vertical flue is extended to the top and closed by a cast iron cover which allows the inspection of each individual flue. Under each oven are two regenerators, one on the pusher side and one on the coke side.

Each oven has four charging holes and a gas offtake at the top, the latter being at the coke side. The coal charging equipment consists of two larry cars, each having four hoppers. One car is sufficient for ordinary needs, the other acting as a spare. The levelling is done through an individual door located above the pusher side door, the latter being just high enough to admit the ram head. This arrangement has been a continual source of trouble due to inability to keep a tight joint around the leveller door frame but this has been remedied on the new ovens and the rebuilt ovens by making the level door a part of the pusher side door. This construction also has the advantage that a carbon scraper may easily be used on the ram if carbon collects in the top of the oven chamber.

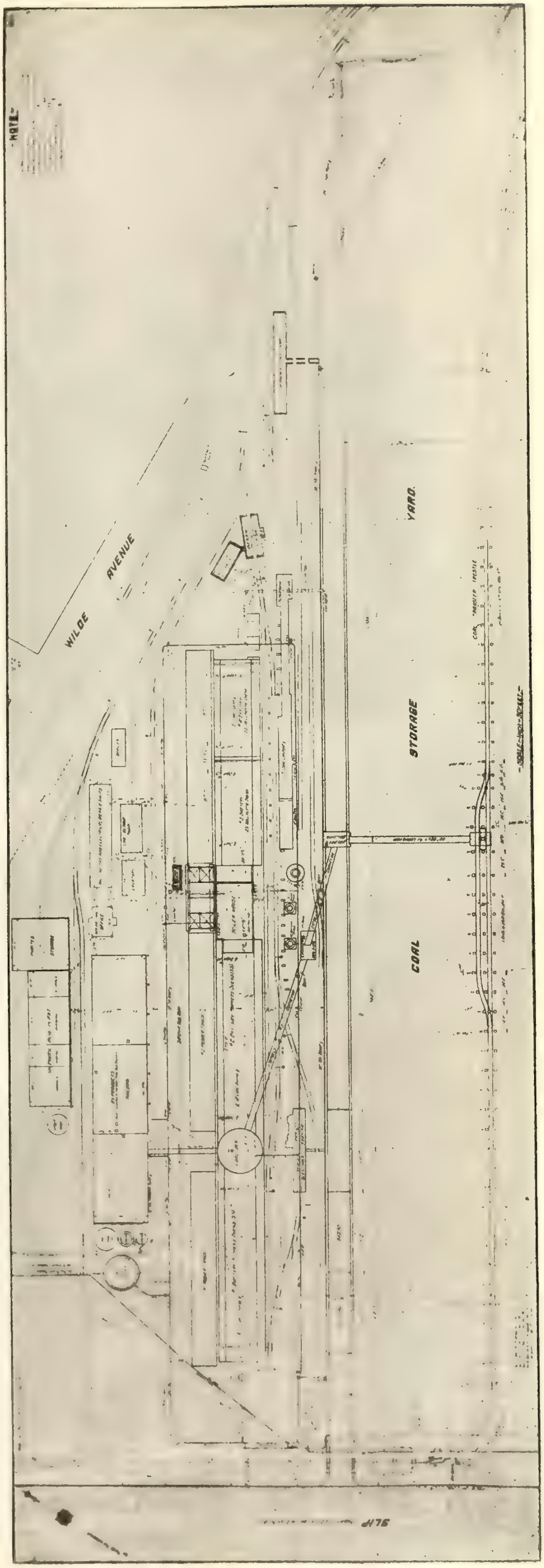
On the pusher side the equipment consists of two Brown Hoist, combined pusher and leveller machines, each machine also being equipped with door handling apparatus. The coke side apparatus consists of two door machines, two coke guides and two clay carriers, all being suspended from an overhead track.

With these ovens, which were guaranteed for a twenty-two hour coking time, it was possible to get down to a coking time of eighteen and one half hours. With this coking time the twenty-four production is:

1300 net tons Blast furnace coke
18.6 " " Ammonium sulphate
11000 Imp. Gal. Tar
130 Net Tons Braize and small coke
7,500,000 cu. ft. Surplus gas.

The original coke handling equipment consisted of ten quenching cars and three electric locomotives. The coke, after being quenched, was taken directly to the blast furnace bins in these cars. After working this way for a short time it was found to be impracticable on account of (1) necessity of over quenching to avoid fires in blast furnace bins. (2) Large amount of switching necessary. (Each car holds one oven, about nine tons of coke). (3) Trouble with freezing in cold weather. (4) Cars are not properly designed for this service.

Then a temporary coke conveyor was built so as to load the coke into rack cars. This is a thirty inch belt conveyor and is equipped with a bar screen having one inch spaces. The small coke and braize passing through this screen is separated into domestic coke and braize by a rotary screen, the former being sold for domestic purposes and the braize used for firing boilers at the steel plant.



General Layout of Coke Oven Plant.

Coal Storage Arrangement, Showing Heyl & Patterson Bridge.

Coke side of old Koppers Battery.

Coke side of new **Wilputte** Ovens, and Coke Conveyor.

Showing pusher side of new **Wilputte** Owens, and cross-over Mains.

The quenching system originally consisted of an overhead spout at every fourth oven, fed by a six inch water line. This did not furnish sufficient volume of water and was soon replaced by a large single spout at one end of the battery. The quenching obtained by the use of this spout was very good, in fact, fully as good as that obtained by the spray quenchers now extensively used and had the added advantage that if the coke was bunched up in one part of the car, that part could be given more water. The big disadvantage was that no way was provided to take the steam away and it made working conditions disagreeable. Lately a spray quencher of modern type has been installed.

The collector mains are on the coke side of the ovens, the back pressure being controlled by a butterfly valve operated by a Northwestern governor. The foul mains go along the coke side to the coal bin thence down to a trench and across to the by-product building. With the exception of the tar loading tank, final coolers and gas holder, all the by-product apparatus, including tar and ammonia storage tanks, is inside the by-product building which consists of a still and tank room, exhauster room and sulphate storage.

The by-product apparatus consisted of three primary coolers, three Connersville exhausters directed connected to vertical, non-condensing, steam engines; three tar extractors; three re-heaters; three saturators, each with two centrifugal dryers, mother-liquid vats ammonia stills, tanks, etc. This was augmented later by two electrically-driven exhausters and two final coolers, the latter being found necessary to remove the naphthaline which caused too much trouble in the fuel mains to the batteries and in the gas line to the mill.

The collector mains are flushed with a mixture of approximately 50% tar and 50% ammonia liquor. All the tar and liquor condensing in the collector mains, coolers, tar extractors and mains is pumped into a separating tank of 70,000 imp. gallons capacity, the tar from the bottom flows to a 60,000 gal. storage tank and the ammonia liquor from the top to a similar storage tank. The tar is sold to the Dominion Tar & Chemical Co., who have a plant adjacent .The ammonia is distilled from the liquor by two ammonia stills and returned to the gas, to be removed by the saturators.

Steam is provided by three 300 H. P. B. & W. boilers located at one end of the batteries and fired with gas.

Water was originally supplied by two electrically driven centrifugal pumps but now the water is obtained from the steel plant pumping house.

The surplus gas is used in reheating and soaking pits at the Steel Plant.

In April 1915 an agreement was made with the Toronto Chemical Co. allowing them to extract benzol, toluol and their homologues from the coke oven gas. They erected an Edison type benzol plant and started to operate in June of that year. The plant was operated successfully until June of this year when it was decided to shut down owing to the poor market for their products.

Shortly after the coke plant was started a sulphuric plant was erected to supply the acid necessary to make sulphate. The plant is of the Falding type, having a single chamber 35 feet by 35 feet by 75 feet high. The sulphur is obtained from pyrites produced at the Company's mines north of the Soo. The ore consists entirely of fines and contains about 40% sulphur. It is roasted in six O'Brien roasters each having a capacity of five tons per twenty-four hours. The plant has a capacity of twenty tons of 60 degree Baume acid per

Showing By-product Building, with Coke Plant Office on right, and Acid Plant in background.

twenty-four hours. The cinder from the roasters is sintered and used in the blast furnaces.

In 1918 the erection of an additional blast furnace made extensions necessary at the coke plant. These extensions consisted of 50 Wilputte ovens, increase of coal storage space, and an additional primary cooler.

The main points of difference between the Wilputte and the Koppers ovens are (1) The air for combustion is provided by a Sirocco blower and distributed to each flue by a six inch wrought iron pipe at the bottom of each regenerator, having a carefully calibrated hole for delivering the air for each flue. (2) The regenerator of each oven is divided by cross walls so that, practically, each flue has its own regenerator. However the regenerators of the same flues in adjacent walls are connected by openings through the regenerator walls.

The door machine on the coke side is operated entirely by electricity, doing away with all hand labor, and the coke guide is arranged so that the coke is entirely supported by the guide and not by the inspection walk as on the old Koppers ovens. This does away with some labor and it is much easier to keep the place clean. The collector mains are on the pusher side and connected with the by-product by overhead mains.

One of the original batteries of Koppers ovens is now being rebuilt and the Kopper Co. have incorporated all the modern improvements such as coke side door machines and coke guides, decarboning device, etc. The division of the flues has been rearranged so that there are fourteen on the coke side and sixteen on the pusher side as the old 13-17 arrangement tended to give green coke in the centre of the oven on low coking time. The width of the oven was changed from 17 in. 21 in., to 17″-18½″, as the tendency in modern practice is to decrease the width of the oven to give lower coking time and better by-product yields. The collector mains were left on the coke side as they caused no trouble there and it is the writer's opinion that this location may have something to do with the non-accummulation of carbon in the oven chamber.

This battery has been in operation eight years with one shut down, Sept. 1914 to July 1915.

Its failure was not due to failure of the silica brick but was undoubtedly due to poor design of the oven jamb, the clay brick of the jamb having been bonded into the silica brick of the oven wall. The difference in expansion between the clay and silica brick made it practically impossible to keep tight joints in the jamb and this combined with the constant trouble with leveller door frames, as previously mentioned, caused occasional fires around the buckstaves. In time these warped to such an extent that they failed to properly support the brickwork, which consequently failed. Failure was probably hastened by neglect of these leaks in times of shortage of labor. The source of this trouble has been removed in modern construction by providing a sliding joint between the clay jamb and the silica brickwork. In the Wilputte ovens it is avoided by making the jamb entirely of silica brick and facing it with a cast iron plate.

The plant is fully equipped with recording gauges which make possible a close check on operating conditions.

There is an independent coke plant laboratory which carries on routine tests and some research work. Our routine tests consist of:

View of Coke side of original Koppers batteries with by-product and acid plant in background.

1. Shatter test on coke.
2. Coal analyses.
3. Sulphate ''
4. Tar ''
5. Crude liquor analyses.
6. Still waste ''
7. Saturator liquor ''
8. Saturator loss determination.
9. Air requirement.
10. Acid plant tests.

Of these the shatter test and air requirement deserve special mention. The former consists of sampling the rack cars of blast furnace coke and dropping 50 pounds of this sample four times through a distance of six feet into a steel plate. It is then screened over a two inch, round hole screen and the percent remaining on the screen determined. This test gives a fairly accurate indication of the burden carrying quality of coke in the blast furnace. The air requirement test is the determination of the volume of air necessary for perfect combustion of one volume of gas. For the heaters use it is fully as valuable as a B.T.U. determination and is much easier to make.

The standard coal mixture has been 65% of Cannelton and 35% of Pocahontas but mixtures have been used varying from 55% Cannelton—45% Pocahontas to 80% Cannelton—20% Pocahontas without causing poor blast furnace practice.

The additions recently made and the rebuilding of the Koppers battery have conformed to up-to-date practice. A rebuilding of the second Koppers battery and improvements to the coke conveyor are contemplated next year. When this is done the Coke Plant of the Algoma Steel Corporation will be on a par with any of the modern plants.

Limonite Deposit Near Lillooet, B.C.

FROM OUR B. C. CORRESPONDENT.

Large deposits of limonite iron ore, carrying high percentages of mineral with small percentages of impurities, and suitable in a superlative degree for fluxing with the known extensive magnetite iron deposits of the Province in the production of pig iron, were reported some months ago on the Taseko (Whitewater) River, Clinton Mining Division. The exact location, it was ascertained subsequently, is some miles from Lillooet, not many miles from the Pacific Great Eastern Railway.

In compliance with the application of the stakers, and acting under the authority of the Mineral Survey & Development Act, Hon. Wm. Sloan, Minister of Mines, instructed Wm. Brewer, one of the Government mining engineers, to visit and submit a report on these properties. This he has done and his findings, while his conclusions are general and his estimates no more than approximations owing to the short time he was able to spend on the ground, are of so favorable a character that Mr. Sloan felt further investigation to be important. To this end, with the approval and the consent of Hon. Martin Burrell, Minister of Mines for the Dominion, the services of S. J. Schofield, senior geologist with the Geological Branch, Ottawa, were secured. Mr. Schofield and party, accordingly, have left for the Whitewater, the former's instructions being to make as thorough an examination of geological and local conditions and to prepare a report at as early date as possible. As this report may have a considerable influence on any action that may be taken by capital towards the establishment of an iron and steel industry in the Northwest it is satisfactory to know that Mr. Schofield is a geologist of the highest attainments commanding the confidence of the mine operators of America. He surveyed the Cranbrook Map Area, has done other important work in British Columbia and in Canada, and was engaged in a geological survey of the Britannia Field at the time he was requested to make the trip to the iron deposits in question.

Mr. Brewer referring to the quantity of ore on the Whitewater, states that ''the superficial area covered by the various exposed deposits examined—is roughly estimated at four hundred acres, but there is a possibility of this extent being much larger because in places there are indications of ore deposits at present covered by tallus, grassy hummocks or hidden by timber. In estimating, tonnage of actual ore, meaning thereby such quantity as development has exposed as measurable and immediately available, the only method to adopt in the absence of development work, is to credit the various deposits with an estimated average thickness, judged from experience in mining similar deposits.'' He then proceeds to estimate, with the foregoing qualifications, as follows.:

Actual Ore—7,200,000 tons carrying above 40% metallic iron.

Probable Ore—15,000,000 tons carrying above 40% metallic iron.

Possible Ore—50,000,000 tons carrying above 40% metallic iron.

''No consideration,'' it is added'' is given to samples of partly mineralized rock which assayed 20.2 and 16.4 per cent iron.''

Discussing the quality of the ore, Mr. Brewer states that assays of samples taken during the examination show that the material classed as ore contains from 41 to 50 per cent metallic iron; that four out of nine of these samples contained only traces of phosphorus, one sample 0.04 per cent, and the remaining four 0.23 per cent, 0.21 per cent, 0.85 per cent and 0.52 per cent, respectively. These results place five of the samples within the Bessemer limit, with the remaining four above the Bessemer limit, but not in excess for the basic or open hearth process of making steel. ''These results,'' he continues, ''show that the ore can be used either in a blast furnace as the entire charge of iron ore or will make a most desirable mixture for combination with the magnetite ore of the Province.''

As to the cost of mining it is said that these deposits of limonite are so located and made up of such comparatively friable material that they can be mined with a steam shovel and the cost of the actual mining, it is figured, should not be above 25 cents a ton.

In reference to transportation it is pointed out that there are at present no transportation facilities nearer than Mission on the Pacific Great Eastern Ry., at least sixty miles distant from the occurrences of iron ore described. Therefore, before any statements can be made, relative to the future facilities, surveys are necessary to determine the most feasible route as well as the location of the manufacturing plant for treatment of the ore.—Canadian Mining Journal.

Experimental Brick Plant of the Nova Scotia Steel & Coal Company, Ltd.

By A. DAWES.*

It is a well known fact there are in parts of Nova Scotia deposits of clay having all the necessary qualities for the making of good firebrick, but, excepting in one or two notable instances, they have been, up to the present, sadly neglected. Shales and clays over and underlying the coal measures of this Province which have proved to be valuable material from which firebrick might be made, have had little attention devoted to them, one of the reasons advanced being that as the seams are held under lease, the operators are indifferent to add the industry of brick making to their main business, which is that of coal mining. There is very little doubt that if the matter were taken up systematically in many instances what is now a waste product would prove to be a profitable by-product, and well worth the capital expenditure involved in the necessary brick-making machinery.

The Nova Scotia Steel & Coal Co. hold extensive coal leases in the Island of Cape Breton. They are operating at the present time five collieries, the Town of Sydney Mines being the center. Samples of the "stone" in their various collieries have been repeatedly analyzed and sufficient information obtained to warrant them in assuming that good fireclay existed interbedded with the coal seams, which, with the admixture of "grog" would make firebrick of sufficiently refractory qualities to be useful for many purposes, incidental to the operation of the blast furnace and steel making plant located in the same town.

Brick Plant of the Nova Scotia Steel Co., showing Shubenacadie clay pile in foreground.

Mill Building, Drying Shed and Kiln (showing Open Hearth stacks on the right.)

Practically all the refractories for the plant were obtained from the United States, and even when times were normal, deliveries were more or less erratic, because of the great distance the brick had to travel from the source of supply, so that with the continuation of the war, aggravated by embargoes on shipments to Canada, the company were faced with a serious problem, and at times conditions were so bad that there was every possibility of having to curtail operations owing to lack of brick.

In order to improve these conditions, the company in 1916 decided to build a brick plant of its own, more or less as an experiment, wherein the possibilities of clays from its own collieries and local "rocks" could be thoroughly tried out in the manufacture of brick on which steel making operations depended.

Within three months after this decision was arrived at, the machinery building, together with a small drying-shed and down-draft kiln were built, the machinery installed and in operation.

As originally contemplated, the machinery building was 30 ft. by 60 ft., which was considered large enough to accommodate the necessary machinery and leave a small space for making such shapes and sizes by hand moulding as could not be made in the brick machine. The dry shed was soon found to be too small, and with increased production being demanded, an extension was made, so that its present size is now 80 ft. by 72 ft. A second kiln was also built, the end of the machinery building was extended, and a lean-to shed erected alongside the incoming rail-track in order to prevent the clay from being frozen solid in winter, and at the same time giving it every chance to weather properly. The general layout of the plant as now existing is shown in Figure 1.

The machinery consists of dry-pan clay mill, elevator, wire screens, pug mill, auger brick-machine, dies and wire brick-cutting machine, which were brought from the American Clay Machinery Company, Bucyrus, Ohio. The stone crusher for breaking up brick bats, etc., for grog was furnished by the company. The whole is belt driven by a 90 H.P. motor, 220 volt, 3 phase and 60 cycle. The completed installation cost in the neighborhood of $27,000.00.

The capacity of this plant is about 5,000 bricks per day.

* Superintendent of Power, Nova Scotia Steel & Coal Co., Sydney Mines.

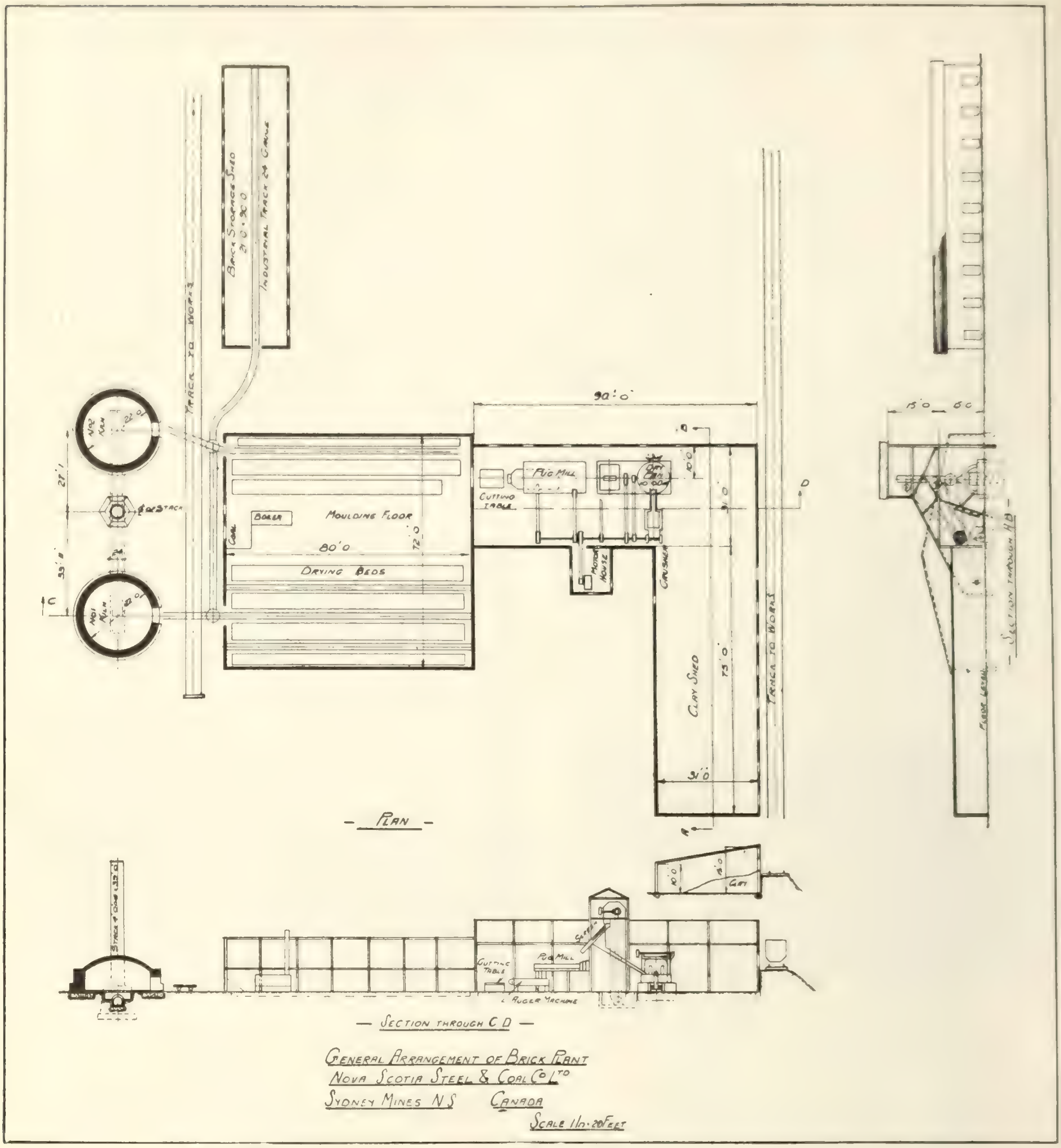


Fig. 1.

The drying shed is heated by steam, pipes being placed in ducts under the floor, the whole being covered by cast-iron perforated plates. Steam is generated in a horizontal, tubular boiler located in this building. Hand trolleys operating on narrow-gauge tracks handle the product from shed to kilns.

The kilns are of the down-draft type and have an internal diameter of 22 ft. They each have 8 fireboxes around the circumference in which the fuel is burnt, the hot gases from these rising up through a series of pockets or "bags" towards the top of the kiln, whence they are diverted downward, distributing themselves through the bricks in the kiln into the flues, below the perforated floor, and thence to chimney stack located between the kilns. Dampers are provided each side of this stack for the proper regulation of draft. Each kiln can be filled in about 2½ working days in all to burn and deliver one kiln of brick. The capacity of each kiln being about 22,000 bricks, the output from both kilns is therefore 120,000 bricks per month or 4,000 per day. To burn the brick requires approximately 1¼ tons of coal per 1,000 bricks.

Different classes of colliery clays have been tested, with the admixture of different kinds and quantities of brick bats for grog, based on the plasticities of the clays and refractory qualities of clays and grog. This

involved a certain amount of preliminary work in making special bricks, heating them to ascertain temperature to which they should be raised before being fully burnt. The burnt bricks were then examined for shrinkage, change of shape, and porosity, and from these results was deduced a good idea of its value of the different mixtures and the correspondingly best kiln treatment.

The results were not too successful at first, only a few clays being found to possess a sufficiently high fusing-point to make them generally useful, but after eliminating a large number which proved to be unsatisfactory, a brick was eventually evolved, of a quality suitable for places where it was not necessary to have a highly refractory brick. These brick are extensively used for the lining of iron and steel ladles, for boiler settings, the under-flues of coke ovens, and other places.

With reference to brick for ladle linings, it should be noted the fusing point of this brick should be low enough, in order that the heat from the molten metal should glaze the surface of the brick, and thus prevent molten metal entering the interstices between the bricks, otherwise, when withdrawing the skull, the brick lining would pull out.

A fairly representative analysis of the colliery clays which the company used for this class of brick is as follows:

Organic Matter..	10.14%	$Fe_2 O_3$........	2.96%
$Si. O_2$..........	54.36%	Ca 0..........	.52%
$Al_2 O_3$........	28.98%	Mg. O........	1.26%

The fusing point is never over 1350° C.

It is found that the most satisfactory material obtained from the collieries with regard to plasticity, chemical analysis, and mechanical adaption, is that obtained from below the coal-seam rather than from the shales forming the roof of the seams. The bricks made from this source are the usual standards, side arches, keys, bull heads, etc., as well as tiles of various sizes.

In the manufacture of higher refractories for blast furnace stoves, coke ovens, open hearth furnaces, etc., the adoption of other than colliery clays had to be decided upon. Many different classes of clay and "rock" from local sources were experimented with, and it was eventually found that very good results were obtained by a mixture of Shubenacadie clay and Coxheath rock. (Shubenacadie is near Truro, Nova Scotia, and Coxheath near Sydney, Nova Scotia.)

The Shubenacadie clay is very plastic, easily worked, and of good binding quality. Its fusing point is about 1670° C., and its representative analysis is as follows:

Organic Matter..	7.76%	$Fe_2 O_3$........	1.30%
$Si. O_2$..........	71.48%	Ca. O..........	.55%
$Al_2 O_3$.........	17.91%	Mg. O........	Trace

The Coxheath Rock becomes quite plastic when ground and worked, and has also a good binding quality. It has a fusing point of 1750° C. with representative analysis as follows:

Organic Matter..	4.46%	$Fe_2 O_3$.......	2.23%
$Si. O_2$...........	79.56%	Ca. O........	Trace
$Al_2 O_3$..........	13.87%	Mg. O.......	Trace

A mixture of these two materials makes brick which have stood up well under the action of heat and gases in coke-oven combustion-chamber walls, stove checkers, gas-producer linings, and other places where highly refractory brick is necessary. Most of these bricks are of large and special shapes, some of them weighing as heavy as 80 pounds. They are moulded by hand. No difficulty was encountered in the burning of these bricks. The material is kilned at a temperature finishing about 1350° C. The brick finishes from a cream to a buff color. Great care had to be used in the first or "water-smoking" stage, and the second or "oxidation" stage, to prevent swelling and burning and consequent bad brick.

To sum up, this plant, which was started on an experimental basis, has proved itself a success, and demonstrated that good refractories can be made from material obtained from the Nova Scotia company's own collieries, and from other sources in the Province. The cost of bricks made in this plant was generally lower than those obtained elsewhere, but the factor which appeals most strongly to those in charge of operations of the steel plant at Sydney Mines, is, that they have on hand a brick-making plant which is a standby against any delays in delivery or hold-ups due to any cause of the firebrick necessary for their extensive steel industry.

G. H. DUGGAN HONORED BY QUEEN'S UNIVERSITY.

At the recent convocation of Queen's University, the honorary degree of L.L.D. was conferred upon Mr. G. H. Duggan, President of the Dominion Bridge Company, and Chief Engineer of the St. Lawrence Bridge Company, during the building of the Quebec Bridge. Mr. Duggan is a past-President of the Canadian Mining Institute and of the Canadian Society of Civil Engineers, and congratulation has already been extended to Mr. Duggan by the Montreal Branch of the Engineering Institute of Canada, and will doubtless be forthcoming from the Canadian Mining Institute. The Faculty of Queen's is also to be congratulated on having observed, what has apparently been overlooked by more august but less discerning bodies, that the erection of the Quebec Bridge was an outstanding and notable achievment in Canadian engineering annals, and of much greater value than many breweries and many newspapers.—Can. Mining Journal.

G. H. DUGGAN.

The By-Product Coke Ovens at Anyox B. C. and the Cassidy Colliery of the Granby Consolidated Mining and Smelting Company

By Our Victoria Correspondent.

To the enterprise of the Granby Consolidated Mining & Smelting Co. is to be credited the giving to British Columbia of the first important by-product coking plant on the Pacific Coast. The project, which was started during the war, was completed only a few months ago, the obstacles which were encountered, first in respect to the clearing of the necessary site at Anyox, the Company's mining centre on the northern Provincial coast, and second in the obtaining of material when what was required was at a premium in Europe, impeding progress somewhat more than was expected. Each difficulty however was surmounted and the modern 30 oven coke and by-product plant stands a monument to the faith of this great Company in the mineral possibilities of Canada's most westerly Province.

On July 9th of this year the first big red-hot cake of coke, measuring nearly nine feet high, forty feet long and nearly eighten inches in width was pushed from one unit of the oven into the waiting car to carry it to the quenching station. That product, it is to be noted, was the first output of an installation which represents an expenditure of approximately $5,000,000, if the plant at Anyox and its attribute, the coal mines of Cassidy, Vancouver Island, are both considered. The coal used in the ovens under discussion comes from Cassidy, it should be understood, where the Company, having acquired coal lands, developed them, installed equipment modern in every respect, built houses for its officials and for its men that are unequalled in the provision made for the well being of employees on the continent. These mines now are producing consistently, the output is shipped by barge to Anyox and there converted into coke for the operation of the Company's smelter.

Of Anyox and its mines and its smelter, which contain the biggest copper converters in all of Canada, much has been written. The town itself and its works today represent an expenditure of practically $8,000,000. Of this amount more than one half was spent before the Company marketed a single pound of copper to the world. To keep the smelter going huge quantities of coke were purchased from the ovens of the Fernie district. Sometimes strikes, which happened too frequently, made the problem of copper production one of endless worry and great expense. At one time the Company was forced to bring its coke from Pennsylvannia. Hundreds of thousands of fuel oil have been transported to the northern camp.

Coke troubles, by virtue of the plant now in operation, are settled, while the vast amount of gas that is saved will be used in firing boilers in power houses when hydro conditions become such that water power is stilled by the lowering temperatures and ice. For the by-products there is a steady market.

Contrary to impressions which have been apparent this coke plant is not of foreign design. Every element of it is the product of the inventive genius of inventors of the North American Continent and every particle of material in its construction was fabricated in Canada, and much of it in British Columbia. The contract for its construction was taken over by the Foundation Company Ltd., of Montreal, and it may be said to be an "All British Product". Only such material as it was possible to obtain in Canada has gone into its construction while the army of skilled artisans who put it together was brought from all sections of the Dominion.

The construction work of the big coal bins, the offices, the huge stacks, the coke ovens themselves, the big gas holder, scrubber and benzol plant, by-products house, all are of concrete, presenting an imposing sight by day and marked by night by immense gas torches where the overflow of fuel burns incessantly. The plant entire spreads over several acres, room for which was blasted out of solid rock, or filled in with the same material. On an eminence to the north stands the smelter, while between the smelter and the coke plant lies the town of Anyox, and up the valley of Hidden Creek are the mines which furnish the ore. Viewed from the waterfront Anyox represents a big industrial concern where two thousand or more skilled workmen ply their vocations for twenty-four hours each day, working in eight hour shifts. The reaches of Granby Bay skirt the town limits, and docking facilities bring the coal from Cassidy almost to the open maw of the coke ovens.

F. M. SYLVESTER
Managing Director, Granby Consolidated Mining & Smelting Company.

Encased in brick of many and peculiar shapes, brick made by a special process, and under the heat of which ordinary fire brick would fuse, the ovens, thirty in number, spread over an area of more than 200 feet and are more than twenty feet in height. It is scarcely necessary to say that the by-product coking ovens create the coke by an entirely different method to the "beehive" ovens which are in use in the Crow's Nest Pass District. No flames touch the coal in its raw state, the fuel passing through flues made of the special brick referred to which so heats the oven walls so as to make them incandecent, thus forcing the coal to throw off its wealth in by-product.

In the carbonization of coal, which is accomplished by the application of heat at 2,400 deg. fahr. the coal gasses are driven off from the ovens to the collecting main, a large "U" shaped steel tank running the full length of the ovens and connected from each oven unit by ascension pipes. Through the collector main gases are conveyed through a series of piping to the by-product house where the gasses go through a condenser. It this condenser the temperatures are dropped, causing the precipitation of the tar and ammonia vapors. The gas then passes through the exhauster to the tar extractor where the remaining tar and ammonia is recovered.

The tar from the condensers and from the tar extractor flows to a tar separating tank and in this tank the tar and ammonia liquors are separated by gravity, the tar flowing to the tar storage tank and the ammonia liquor to the ammonia liquor receptacle. The ammonia liquor is then sent to the Ammonia Still where it is driven off in the form of gas which combines with the gasses leaving the tar extractor and all gases are then sent to the Saturator. In the Saturator the gases pass through a bath of sulphuric acid, the ammonia combining with the acid, forming ammonia salts, or ammonia sulphate. These salts are deposited in the Saturator, then conveyed to a draining table, and when a sufficient amount of salts have been collected it is placed in centrifugal dryers and the moisture driven out. Then the Ammonia Sulphate is ready for the market.

The operation at the by-product houses being completed all the gas passes to the final cooler in the benzol plant where the following by-products are obtained: Benzol and its homologues, which are toluol, solvent naphtha, crude naphtha and xylol. In the cooler the gas is brought into direct contact with a water spray, and the naphthalene, as a result of the cooling gas, is carried off into a settling tank where the naphthalene floats to the top and is there skimmed off. The gas then goes from the final cooler to the scrubber, where the gas is washed and brought into direct contact with straw oil which absorbs the light oil in the gas. The latter then is carried to the gas-holder where it is stored. About 40 per cent of the entire amount of the gas generated is used in firing the coke ovens. The remainder will take the place of at least 1,800 barrels of oil daily during the winter months for heating the boilers of the power-houses which furnish compressed air to the mines and smelter.

General office, Cassidy Colliery, Vancouver Island.

The straw oil, or gas oil, which is a by-product of an oil refinery, takes from the gas the benzol and its homologues and the straw oil, when it has absorbed the light oil, becomes what is known as benzolized oil. It then is sent to a Still where it is thoroughly distilled and by the application of heat becomes benzol. The wash oil, when it collects in the Still, is sent to a cooler through a maze of pipes and is re-used in the scrubber. After the benzol has been driven off the temperature in the Still is increased and toluol is driven off. After this the temperature is again increased and solvent naphtha is driven off. By a process of re-distilling these products are made pure and marketable.

Coke Plant at Anyox, B. C. Smelter is seen in the distance.

The dimensions of the ovens are as follows:

At one end 18 inches wide, with a spread of three inches added to the other end in order that the big electric ram which pushes the coke from the oven will go clear; they are nine feet high inside measurement and forty feet long. With slight reduction that is the size of each cake or slab of coke as it leaves the oven.

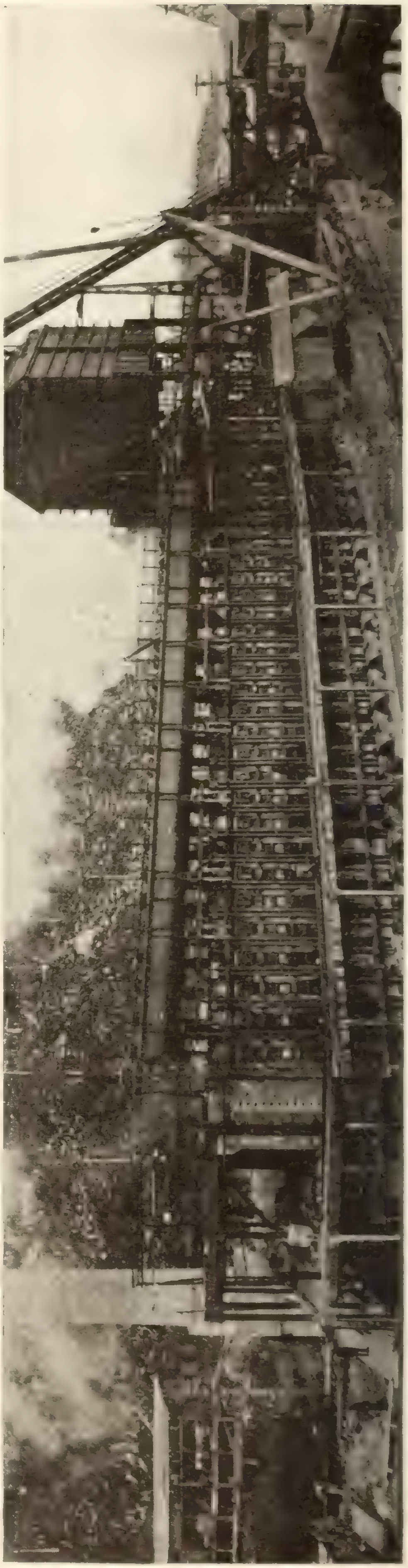
Charging of the ovens is done by the larry which is fed from the elevator at one end of the ovens where the pulverized coal has been transferred from the bunkers over an endless belt. This larry runs upon an electrified track, stopping over the hatches of each oven long enough to perform the mission of recharging. As the coal is carbonized to the finished state the oven doors are automatically removed from both sides of the ovens and an electric ram pushes the red hot cake of coke through the ovens and dumps it into a steel electrically propelled tramcar. It is then run into the quenching station, where water automatically flows upon it sending off great clouds of steam and shattering the coke by impact. It is then transported over the same line to coke bins conveniently placed where it is loaded into cars and makes its way to the smelter Each oven holds 13½ tons of raw coal which when carbonized leaves its residue of coke, 65% of the whole. The greater part of the balance has gone into by-products and gas. Carbonization in each one of the thirty ovens is effected in eighteen hours.

The by-product oven offers a complete solution of the fuel problem, the plant at Anyox having a capacity of 500 tons of coke daily. The raw coal passing through its transformation process is resolved into elements of solid and gaseous fuel, its impurities are removed and made into articles of commercial value, with a total loss of efficiency in the conversion that is already less than that of any gasifying process known.

Visualize the fleets of gasoline boats that may be supplied by the benzol alone that goes to waste in the ordinary process of raw coal consumption. It is a colorless liquid possessing great inflammability and mixed with gasoline takes up the burden of motive power at a cheap account. It is used in the manufacture of paints and as a solvent for rubber. It is used in explosives and in the preparation of perfume. Such are a few of its uses while its homologue ammonia, transformed into ammonium sulphate, furnishes a fertilizer market practically unlimited, particularly at this time as Chilean nitrate is becoming scarcer each year owing to the depletion of the mines.

From each single ton of raw coal out of the 13½ that are carbonized every eighteen hours in the ovens of the Granby plant, there results 65% of the total weight in coke and 11,500 cubic feet in gas, ten gallons of tar, 21 pounds of sulphate of ammonia, 3 gallons of light oil, 1.55 gallons of benzol, .40 gallons pure toluol, 30 gallons solvent naphthalene and 4 pounds crude naphthalene.

From the tar the by-products are so numerous as to be staggering in their possibilities. Creosote is extensively used in all seaport cities where docks and wharves are built as a preventative against the inroads of the teredo, while the application of pitch is too well known to need comment. An immensce tank of steel has been constructed at the Anyox plant to take care of the coal tar which runs in a steady stream from the coke ovens.



Coke side, Coke Ovens at Anyox, B. C., showing quenching car at left, and pusher at right.

While the establishment of this fine plant at Anyox is an outstanding accomplishment, the Company also is to be congratulated upon the splendid coal mining centre opened up at Cassidy, Vancouver Island. Cassidy is regarded as a model, having no duplicate on the North American continent. Its coal mine is believed to be the best equipped in the entire world, while the comforts provided for employees are far ahead of anything known in Canada. The townsite is laid out with wide streets, the whole design being most artistic. Native trees designate the names of the streets, such as Hemlock Street, Cedar Street, Fir Street and so on through the native arboreal nomenclature. The product of the entire nursery was purchased to make the town and streets attractive, while borders of flowers lend a piquant charm. Electrically lighted at night the streets give the appearance of a city of pretentions. Mr. F. M. Sylvester, Managing Director of the Company, is largely responsible, and the comments of those who visit Cassidy and the appreciation of those who live there strikingly indicate his success.

For the married employees there are cottages of the bungalow type on ample ground space no less than fifty by a hundred feet. The houses are of the most modern build and are provided with the most modern sanitary equipment. They have hot and cold water, electric light and sewage systems. One portion of the townsite has been laid out for sports. Here will be found baseball grounds, tennis cricket, football, lacrosse. A running track also has been laid out. Its location is one that is admirable. From a height of land surrounding it forms a perfect amphitheatre. A gymnasium is being provided and everything necessary to physical culture is being adopted.

Cassidy Colliery, Vancouver Island.

A model is again encountered in the rooming houses for the single men, while the mess house bears out the same idea and thought of cleanliness and comfort. The mess house can be compared only to a first class hotel. Trailing vines and rosebushes lead the way to the entrances. A wash and change house is provided. Waitresses are in attendance upon the tables and the selection of food is made from a well-balanced and splendidly wholesome bill of fare. Tables are not of the old style where hundreds of men sat in rows and scrambled for food. Each table seats six men and each one of the six at every table in this dining room, where 200 men can be accommodated, is given "service". The kitchen is another model. It is as nearly electrically operated as is possible.

Hidden Creek Mine of the Granby Consolidated Mining Company.
150 ft. tunnel.

In the rooming houses the best that money can buy has been provided for comfort. In fact the room may be placed on plain with those found in the homes of the well-to-do. Up-to-date furniture is there, hot and cold water, steam heat. Each room in the two stories opens upon a verandah or balcony where flowers are growing. Every room is an outside room. The Company furnished the bed clothes and blanket. There is not an item overlooked to make these rooms sanitary and comfortable. Should a miner emerge from the mines with wet clothes there is an attendant to see to it that he gets clean and dry clothes to replace his soiled ones. Shower baths, hot and cold, form part of the scheme for cleanliness and health. The smallest detail along the lines indicated, besides the actual coal mine operations, receive the attention of R. R. Wilson the Superintendent.

The coal from Cassidy, that is suplied to the Coke plant at Anyox is mined from a slope following the dip of the seam at an angle of about eighteen degrees. This slope is open to a depth of about 2,000 feet. A manway has been provided as a safety-first measure and the men are not permitted to enter the mine by the working slope. The operations are pillar and stall. The mine is splendidly timbered. Every precaution known is taken against explosion and indeed against every form of accident. The men are provided with electric mine lanps and a sirocco fan, with a capacity of 150,000 cubic ft. of air a minute, is the mainspring of the ventilation system. An accident at the mine cannot affect the fan, the fan house being situated so that it cannot be interfered with. The fan house is built of concrete. Mechanical stokers feed the coal to the boiler furnaces from the sludge of the washery period. Exhaust steam is used for heating and its return is made from the pipes to the condensers and used over again. There is not a particle of waste coal. Even the refuse from the washery is flumed to a dump where it may be taken care of, it being thought that some day a use may be found for it. Utilization of every resource in the Cassidy coal plant is the theory upon which its designers have worked. Screens provide four grades of coal. Anyox get the small coal and varying grades are placed on the market. With Anyox extracting every available by-product from coal taken from Vancouver Island for coke production the way has been pointed to a most desirable revolution in coal mining methods in British Columbia.

The Hidden Creek Mine Camp.

Company Notes

CANADA FOUNDRIES & FORGINGS, LIMITED.

Allied Plants of the Company Have Doubled Capacity and Have Reached Peace-time Objective For Present Year.

Since their inauguration of peace time operations, the Canada Foundries & Forgings, Limited, owners and operators of the Canadian Billings & Spencer Company, Limited, and the Canada Forge Company, Limited, of Welland, and the James Smart Manufacturing Company, Limited, of Brockville, Ont. have doubled their capacity. Beginning on January 1st the company started in to work day and night shifts and already the heavy forging end of the industries and other departments are up to the peace time objective set for the present year while efforts are now being concentrated on the further development of the already large export trade. Special representatives are now located in England and India and representatives are being sent to France, Jamaica and the West Indies. At the plant of the Canadian Billings & Spencer Co. in Welland, which was established in 1907, drop forgings of steel of every description are being turned out and the firm carry a complete stock of engineers' wrenches, general service wrenches, bull-dog wrenches, combination pliers, machinist hammers, journal wedges, etc. At the plant of the Canada Forge Co., Limited, in Welland, ship and locomotive parts and die blocks of electric steel are being manufactured and the James Smart Mfg. Co., Limited, plant in Brockville is devoted to general hardware, stoves and furnaces. Mr. B. J. McCormick, of Welland, is the energetic general sales manager of the combined industries.

NATIONAL CAR COMPANY TO BE REORGANIZED

President Sir John Gibson Announces Deficiency of Over a Million Dollars Due to Losses on French Contract Chiefly.

In a circular letter just issued by the president, Sir John Gibson, it is stated that heavy losses on their French contract for the supply of cars has crippled the National Steel Car Company, Limited, of Hamilton, reorganization of which is now under way. The following is given by the president as a summary of the financial position of the company as of Sept. 30th, 1919:

Accounts payable	$3,487,740
Accounts receivable and inventory	1,884,556
Deficiency	$1,603,184

To set off against this deficiency, the circular says, the company has payments coming in as a result of negotiations with the P.L. & M. Railway of France which, at final adjustment should amount to $450,000 as well as its real estate, plant and machinery which have already been appraised at approximately $2,600,000. Few orders for cars are now being placed, and with the completion of the work in hand, and the absence of new orders, a considerable part of the plant has now been closed down, resulting in necessarily operating at a loss. "In view of this," says the circular, "the creditros of the company are insistent that means should be taken at the earliest opportunity to liquidate the company's debts though during the past two years the company has done a satisfactory and profitable business."

After stating that the principal of the $3,000,000 of the bonds is now overdue, Sir John Gibson commends the organization scheme entered into with Donald Symington of Baltimore, Md., and Robert J. Magor of New York, described in the agreement as the purchasers. This contract makes provision for the discharge of the company's indebtedness and for the receipt by the company of 19,000 shares of the capital stock (out of 100,000 shares to be issued) of a new company, into whose treasury will be paid in cash the sum of $1,250,000.

It is generally understood that the Canadian Bank of Commerce is the largest creditor of the company, having made advances said to be in the neighborhood of $2,000,000. The company's outstanding capital stock is $1,500,000 preferred and $2,000,000 common.

The announcement of the deficit, as contained in the president's circular, caused a good deal of surprise in Toronto financial circles and the preferred stock had a loss of 10¾ points on the Toronto Exchange.

Mr. Magor is interested in the manufacture of steel cars in the States and is a brother of Basil Magor who was at one time general manager of the National Steel Car Company.

ANNUAL MEETING OF COCKSHUTT PLOW CO.

At the annual meeting of the Cockshutt Plow Company of Brantford, Ont., held on Oct. 27th, the old board of directors, Colonel H. Cockshutt, George Wedlake, E. A. Mott, Sir Augustus Manton, James Adams, C. K. Wedlake and S. Perry were re-elected. The officers chosen are: Col. Cockshutt, president, managing director and treasurer; George Wedlake, first vice president and general manager.

NEW FACTORY FOR WHITBY.

Whitby, Ont., has been selected as the site of a Canadian plant which the Nash Motor Company proposes to establish for the manufacture of some motor parts and the assembling of cars for the Canadian and British markets. A tract of about 60 acres has been selected as a likely spot for such an undertaking.

BURLINGTON STEEL CO.'S OPERATIONS.

The Burlington Steel Company, of Hamilton, are adding a lunch room, shower baths and other accommodation for their employees. The company recently completed a contract for the T. Eaton Co. at Moncton, N.B., for 450 tons of reinforcing steel. Other contracts that have just been completed by the company are 350 tons for the Hydro-Electric Sulphide plant at Temiskaming and 250 tons for the Hole-Proof Hosiery Company of London, Ont. The firm reports an excellent volume of trade for the past two months and the outlook for the coming year is satisfactory.

The International Plow Works of Hamilton, Ont., contemplates the erection of an addition to their plant. B. H. Prack, Lumsden Building, Toronto, is the engineer.

The Carswell Construction Co., 58 Wellington Street East, Toronto, has the general contract for alterations and the construction of additions to the plant of the Chase Tractor Co., Limited, to cost $40,000. A. H. Harkness, Confederation Life Building, Toronto, is the architect.

The Taylor Forbes Co., Limited, Guelph, Ont., are about to build an addition to their plant costing $9,000. P. H. Secord and Sons, 133 Nelson Street, Brantford, Ont., are the contractors.

The G. W. McFarlane Engineering Company, Paris, Ont., is contemplating inaugurating a wire manufacturing business and will require wire-drawing, weaving, galvanizing, coppering and tinning equipment.

The Canadian Edison Appliance Company, Limited, Toronto, has been incorporated with a capital stock of $1,000,000 by William A. J. Case, James B. Taylor, George E. Atwood and others, to manufacture electrical equipment, machinery, etc.

The Canada Steel and Wire Company of Hamilton have commenced work on a substantial addition to their plant.

The Carr Fastener Company of Cambridge, Mass., are arranging for the construction in Hamilton, Ont., of a $150,000 plant. The firm will manufacture dome fasteners for automobile curtains, etc.

The Norton Company of Worcester, Mass., have bought a site in Hamilton, Ont., and are getting out plans for a plant for the manufacture of grinding wheels for use in steel plants. The Canadian company is capitalized at $500,000.

The Dominion Steel Metal Corporation have just completed a new warehouse at their plant in Hamilton, Ont., at a cost of about $30,000. The product of the company is galvanized iron.

Immediate surveys are to be made for an extension of the railway from Le Pas to the mineral area of Northern Manitoba. The line will be approximately 73 miles in length, and is estimated will cost not less than two millions of dollars.

The Cross Fertilizer Company of Sydney, Nova Scotia, which is a branch of Alexander Walker & Co. of Scotland, is announced to be seeking a plant site at Coburg, Ont.

The Canadian Carbonate Co. of Montreal has purchased a site in Hamilton, Ont., and it is announced will make an immediate expenditure of $100,000 on buildings and plant equipment.

The Firestone Tire & Rubber Co. of Akron, Ohio, propose to establish a Canadian plant in Hamilton, Ont., provided certain civic concessions are accorded the company.

Paquet & Co., Quebec, have been granted building permit for a six-story fireproof steel structure on Des Fosses St., estimated to cost $150,000.

The Champlain Brewery Company propose to build at the corner of Crown and Prince Edward Streets at an estimated cost of $100,000.

The Ford Motor Co. of Canada is expected to commence construction of an assembling plant in Regina, Sask., to cost $100,000.

The Fuller Construction Co. has commenced work on a fireproof hotel structure in Sydney, Nova Scotia, to replace the wooden structure destroyed by fire in the Spring.

A family hotel for Toronto, to cost five million dollars is proposed to be built opposite St. Paul's Church.

The Merchants Bank of Canada and the Dominion Bank each propose to erect new bank buildings in Toronto.

Angus McLean, general manager of the Bathurst Lumber Co., and Major V. J. Hughes, of Montreal, manager of the Canada Iron Corporation, appeared before a meeting of the Provincial Government this week in connection with the plans for the development of water power on the Nipisquit River. The contract, Mr. McLean said, is to be carried out by Morrow & Beatty of Peterborough, Ont., under direction of Wm. Kennedy, Jr., hydraulic engineer. It is proposed to build a dam at Grand Falls on this river to develop 10,000 horse power, to be transmitted to Bathurst, N.B., for the operation of the pulp and saw mills and other industries controlled by the Bathurst Lumber Co. Two generators will be installed at once and arrangements made for the installation of a third, if necessary. The transmission line will carry from 50,000 to 55,000 volts and will be erected on steel poles.

Hamilton, Ont.—The British-American Oil Co., Toronto, has decided to erect a $100,000 plant in this city. A permit for the erection of the building has been issued. President, C. S. Shorman.

Toronto, Ont.—The Canadian General Electric Co. have received a permit to build a new $135,000 warehouse at the corner of King and Simcoe Streets, and a further permit to bridge the private lane between the new warehouse and their present one, at an estimated cost of $2,000. A permit has also been issued to the Canadian Allis-Chalmers Co. for the erection of a pipe-galvanizing plant at the corner of King and Simcoe Streets, which will cost $35,000.

St. Boniface, Man.—Contract awarded to the Carter-Halls-Aldinger Co., Winnipeg, for the erection of a $65,000 foundry for the Western Wheel Foundries Co., Ltd., Messier St.

Sandwich East, Ont.—The General Motors Corporation have purchased 600 acres here. The land, which is near the $6,000,000 plant the corporation is building on the Walker Rd., Walkerville, will be used as the site of a model town for employees. In the meantime temporary quarters will be erected by the corporation. More than $1,000,000 will be spent in building workmen's houses.

Edmonton, Alta.—A station costing approximately $1,000,000 and a big program of expansion will be undertaken by the Canadian National Railways here. The station will likely be five stories high. It is also reported that the company will build shops in Edmonton similar to the Ogden shops at Calgary. The programme has been approved and only requires sanction of the Railway Board. It is expected work will start in the spring.

Saskatoon, Sask.—Contract has been awarded for supply and erection of one 4,500 k.w. turbine and condenser for the power-house as follows: To the Canadian Westinghouse Co., Hamilton, $149,813. Rejected tenders from Dominion Bridge Co., Montreal, $159,-

310; Fraser and Chalmers, Montreal, $164,000. Separate tenders were also received for the turbine generator and switchgear as follows: Canadian General Electric Co., $92,609; Canadian Westinghouse Co., $114,643; Dominion Bridge Co., $126,500; Fraser and Chalmers, $132,000. Separate tenders for the condenser and equipment were as follows: Alberger Pump and Condenser Co., $24,135; Goldie and McCulloch, $29,965; C. H. Wheeler Manufacturing Co., $26,000; Canadian Westinghouse Co., $35,745; Dominion Bridge Co., $32,810; Fraser and Chalmers, $37,650.

LIEUT.-COL. GIBSON RESUMES DUTIES.

Counsel for Lake Superior Corporation is Back at Work After Long Service Overseas.

Lieut.-Col. T. Gibson, general counsel for the Lake Superior Corporation, is back at his desk in the Bank of Hamilton Building, Toronto, after four years spent with the overseas troops. His place with the Lake Superior Corporation was filled by his brother, Mr. Joseph Gibson, during the Colonel's absence. Lieut.-Col. Gibson went overseas as second in command of the 168th Oxford County Battalion, which he was largely instrumental in forming, and went to France in charge of a construction battalion. While serving with the unit as its colonel he was made returning officer for the voting in the war-time election and later was promoted to be Deputy Overseas Minister, in which capacity he was serving until his discharge in Canada a few weeks ago. Lieut.-Col. Gibson was given a great welcome in his home town of Ingersoll, Ont., on his return.

Mr. Arthur Balfour, managing director of the Arthur Balfour Company, (Canada, Limited) has arrived in Canada on a visit to the Canadian office in Toronto. Mr. Balfour is a big manufacturer of tool steel in Sheffield and the present is his first visit to Canada since the beginning of the war. Amongst his various public activities in England during the war was his work in connection with the Government Coal Commission, of which he was a member.

Professor Gray, in his presidential address before the Mathematical and Physical Section of the British Association, said that altogether too much stress is paid upon researches undertaken solely with a view to their applications. "In research," says Professor Gray, "in pure science at least, control will inevitably defeat itself. "The scientific discoverer hardly knows whither he is being led; by a path he knows not he comes to his own. He should be free as the wind." —From the Atheneum.

METAL QUOTATIONS.

Fair price for ingot metals at Montreal at the beginning of November:

Electro Copper, per lb.	24½c
Casting Copper, per lb.	24c
Lead, per lb.	7¾c
Tin, per lb.	56½c
Zinc, per lb.	9¾c
Antimony, per lb.	9⅞c
Aluminum, per lb.	32c

Steel Bars	$3.10
Plate	3.35

CENTRIFUGAL STEEL PIPE MAKING.

National Steel Corporation, Limited, of Toronto, have tried out new system with marked success.

The National Iron Corporation, Limited, Cherry Street, Toronto, manufacturers of steel pipe, have been trying out a new method of casting iron pipe and part of their operations are being devoted to the turning out of machinery, which, it is predicted, will some day come into universal use in the making of steel piping. The firm have already shipped one of the machines to France and a representative of a Japanese firm of manufacturers is with the company now receiving instruction in the process with a view to introducing it into his plant in Japan.

The method was devised by a French engineer and it is being commercially undertaken both in Canada and the United States, the claim being that it will revolutionize the pipe making industry by reason of the fact that it produces a stronger pipe and one that will not burst under a high pressure. Of course before it can come into general use in this country it will be necessary for the Canadian Society of Civil Engineers to alter the standard.

In the method employed, a rotary, water-cooled cylindrical mold receives the molten metal, no sand being used. The iron, at very high temperature, is poured through the funnel into a trough, which is immediately introduced into a revolving mold and turned over. Centrifugal force distributes the metal evenly, and as graduated ladles are used, there is no waste. The finished pipe is withdrawn a few seconds after the iron is poured, coming out lengthwise quite easily. The walls of the pipe so cast are remarkably thin and uniform, and tests indicate greater strength and closer texture than result from the ordinary casting in sand. Many experiments in centrifugal casting of iron pipe have previously been tried but did not prove commercially practical. The success of the system is attributed to a cold mold and the instant withdrawal of the pipe which hardens as soon as poured.

Mr. Roderick J. MacLean, of MacLean & Barker, Montreal, has returned from a business trip to England.

Mr. G. E. Leighton, representing the Hardy Patent Pick Co. and other Sheffield manufacturing interests, has returned to Montreal from England.

SALESMEN MEET IN CONVENTION.

That a fine spirit of co-operation exists amongst the Ontario sales force of the International Business Machines Co., Limited, was apparent at a convention of the salesmen at the Toronto factory, 300 Campbell Avenue, Toronto, on Oct. 17 and 18 when many problems affecting the selling end of the business were discussed and suggestions exchanged. F. E. Mutton, vice president and general manager of the company presided over all the sessions, some of which were devoted to demonstrations of the company's varied products. H. S. Kearns and George Reavely demonstrated the workings and selling points of the different scales and the selling arguments of the International Autograph Recorder were presented by Mr. Mutton. As a suitable wind-up to the convention the sales force and company officials sat down to a banquet in the King Edward Hotel.

Shipping Notes

The Pacific Coast.

The steamship Montreal, 3,500 tons, built for the French Government, was launched on September 30 from the Point Hope yard of the Foundation Company, Victoria, B.C.

The erection of a ship fitting out plant to cost approximately $1,000,000 which will employ 1,500 to 2,000 men, is said to be assured by the sale of a large piece of waterfrontage on Burrard Inlet, B.C. The sale was made to a local shipping firm, which, it is understood, is backed by New York capital. Rumor connects the name of John Coughlan, head of the Coughlan shipyards, with the purchase. The property comprises 200 feet of waterfrontage adjoining P. Burns' packing plant. It has a depth of 555 feet to the C.P.R. main line. Work will commence without delay on the preparation of the property for the erection of the buildings.

His Excellency the Governor-General of Canada will lay the keel of the first of two 8,100-ton steamers to be built at Prince Rupert for the Canadian Government. There is already 95 per cent of the steel for both ships on the ground and the rest is expected soon.

During the first seven months of 1919 thirty-three wooden steamers, five schooners and seven steel steamers, with a combined tonnage of 128,000 and a value approximating $24,000,000, were launched from British Columbia shipyards.

The Coughlan Company has launched the "War Chariot," the last of the 8,800 ton freighters being built for the Imperial Munitions Board. The hull was practically ready a year ago, but was damaged in the fire at this shipyard.

The company has all four keels laid for the 8,100 ton freighters it is building for the Government, and plans simultaneous construction.

It is understood the Government are awarding contracts for four additional ships of the 8,800 ton class to British Columbia shipyards to prevent unemployment which would otherwise arise from the completion of the vessels now in course of construction or approaching completion. The price is believed to be $160 per ton.

Yarrows, Ltd., of Esquimalt, B.C., are to build a 90 ft. steel ferry-boat to operate across the Fraser River at Mission. Owing to the shallowness of the water and the swift current the boat will draw only three feet of water, and will be equipped with powerful propelling machinery. The boat will be a double-ender, two propellers at each end, or four in all.

A direct steamship service between Vancouver, Marseilles and Genoa is now in force, arrangements having been made by which a monthly sailing will be made by vessels of the Societe Generals de Transports Maritimes a Vapeur.

Great Lakes and Maritime.

The "Canadian Navigator," the sixth vessel built by the Canadian Vickers for the Canadian Government merchant marine was launched at Maisonneuve Yard on the 18th October. Dimensions of the vessel are 4,350 tons deadweight cargo capacity, length between perpendiculars 320 ft., breadth, moulded 44 feet, depth 25 feet. Engines and boilers are expected to be installed immediately and delivery of the vessel to the Government is anticipated before the end of November, or in time to get down the River before the ice forms. The vessel will sail for Liverpool as soon as she is ready for sea.

The "Canadian Miller" was delivered by Canadian Vickers to the Government on September 23rd and is taking grain from Halifax to Liverpool, Eng. This vessel is a sistership to the "Navigator."

The new Imperial Munition Board Steamer, War Moncton, has made her trial trip successfully. The keel of the War Moncton was laid on August 29, 1918, and she was launched on May 29.1919. She is 250 feet long with a gross tonnage of 2,300 tons, and is classed A1 Lloyd's, twelve years. Her engines are triple expansion, developing 1,000 horsepower and were built by the Canada Bridge Co., Montreal.

The court of inquiry, under Captain Demers, Dominion commissioner, at Sydney, N.S.., after hearing evidence for two days, has completely exonerated the officers and crew of the S.S. Cape Breton and her owners, The Dominion Coal Company. In April last one of her boilers burst while on her way from Newfoundland to Sydney with iron ore, killing two of the crew outright and injuring others.

The 2,800 ton steel vessel recently launched by the Nova Scotia Steel Co. at Trenton, N.S., was christened the "Canadian Sealer." A sister ship is in course of construction, and keel was immediately laid for a 5,000 ton steel freighter following the launching of the "Sealer."

The Tidewater Shipbuilding Co. of Three Rivers, Que., has launched the "Canadian Settler," a 5,100 ton steel freighter, built to the order of the Canadian Government. Not only the hull, but the boilers, engines and most of the machinery with which the vessel is equipped were built and installed by the Tidewater Co.

The Collingwood Shipbuilding Company has been awarded contract for two additional steel freighters of 3,750 tons each by the Canadian Government. Price is reported to be in vicinity of $180 per ton.

The Davie Shipbuilding Co. of Lauzun, Que., has launched the "Canadian Trapper," of 5,100 tons to the order of the Government. The work of installing the machinery is expected to occupy the Winter and employ some 400 men.

A steel-ship building yard is mooted for Harbour Grace, Newfoundland, according to newspaper reports from St. John's.

It is announced that Mr. J. F. Paige, general manager of the Port Arthur Shipbuilding Company, is leaving there shortly to take charge of the Halifax Shipyards. Mr. Paige is a Nova Scotian, and has been with the Fore River Shipbuilding Company. When in this company's service he visited Japan and Italy in connection with the installation of turbines in Japanese and Italian warships.

Montreal, Que.—A new company, to be known as the Havana Marine Terminals, Ltd., with headquarters in this city, has been granted a charter by the Dominion government. The company is empowered to construct and purchase mills, shops, graving docks, warehouses and other necessary structures; to acquire all kinds of steam and sailing vessels, and generally to carry on the business of a navigation and transportation company. The company is capitalized at $30,000,000. Gordon MacDougall, K.C., is among the provisional directors.

A REVIVAL OF TECHNICAL LITERATURE.

During the past five years the entire absorption of the energies of the British peoples in the defeat of the Teutonic League caused a dearth of technical literature and a great shrinkage in the number of papers read before British societies. A glance at the comparative bulk of the annual transactions of learned and technical societies will show the disparity between the fat tomes of pre-war days, and the lean volumes issued during the war period. This hiatus can unfortunately never be filled in, for many of those who showed promise in scientific and technical investigation form part of the awful toll exacted by war, and will never again move amongst us. It is said that on the opening day of the 1916 Somme battles no less than 170,000 British casualties were recorded, and the flower of the nation died in that and other battles which—although we did not then know it—broke the power of the German army, henceforward only to be prolonged by collapse of our allies in other fields.

While a certain amount of scientific progress has been occasioned by the necessities of welfare, who can say how many undiscovered men of genius, how many inventions and how much of value to science was destroyed by the deaths of war! This chapter can never be written, but we do know that the best, the bravest, and in many instances the wisest of our young men perished untimely.

Acknowledgement of this irreparable loss has formed the theme of resolution and memorial at all our society meetings held since the war ended, and, in looking forward to a revival of society transactions to an extent that will in some measure approach pre-war dimensions, we cannot forget that we shall never recover in the present generation of men, the labours and discoveries of those who have died in war.

We should however, expect very shortly to see the reading of a larger number of technical papers before British societies, and a resumption of that gift for individual observation and research which has enabled the British citizen to send home to the particular technical society to which he may be most particularly attached, accounts of technical progress in every quarter of the globe. This wide range of origin has always been a distinguishing feature of the transactions of societies within the Empire, whether they have their headquarters in South Africa, Canada, Britain, or elsewhere under the Flag.

One result of the war has been the description before our societies of war, adventure and shrewd commercial and technical observation combined, in the remotest and most primitive countries. Now our scattered armies have returned home, and men, after a period of unsettlement and re-action which varies according to the war experience and spiritual make-up of the individual, are settling down to the tasks of peace. Many men look upon the war period as so much time wasted, as a dirty business which had to be done; and which they have well performed, and they return to scientific occupations with renewed love. They will find in work the forgetfulness they desire of things that were unspeakable, and dear only to memory because of the comradeship of those who fought side by side with them, and went through the same hell together. From these men we may expect great things, and not the least of their contributions to our life in peace-time will be their contributions to society transactions, and their presence at our society meetings, as was their wont in the days before the War.

The tremendous and sustained bulk of scientific transactions in the United States is an evidence of the comparatively smaller drain which the war made upon the man-power of that nation, added to which was the selective nature of the drafting for war, which purposely retained at the desk and the laboratory those whose scientific attainments and promise indicated the most effective manner in which these men could serve their country. The tragic feature of the war as it affected the British people was that before conscription was adopted, by a natural selection of the most discriminating kind, the golden youth of the Empire were placed in the forefront of battle, and died there.

That the transactions of our technical societies were kept going at all was in large measure due to the fathers of the societies, who renewed their youth and played the game at home by contributing papers, feigning thereby a detachment from the obsession of the war, which they did not feel, for in too many cases their sons were gone from them.

In the years to come the bound volumes of society transactions, as they stand in the bookcases, will remain a mute reminder of the manner in which the British people entered into a righteous but unwelcome war, and for the space of about five years did little else but light and prepare for more fighting.—Canadian Mining Journal.

I have always thought that the remarks heard in an English crowd are more witty than those of an American crowd. They are not so pleasant to hear, because they are bitter and often very cynical, whereas it is extremely rare to hear Americans of any class say anything wounding in a spirit of jocosity. But not seldom the American wit is of ready-made phrases, held in community, and you feel that the next man or woman who comes within earshot is likely to say pretty much the same thing; while the English man or girl, those of the large towns, constantly say striking things which have never been heard before, and no one will repeat after them.—Vincent O'Sullivan in the "New Witness."

Our Maritime Letter

Ferro Manganese. With the uncertainty of the outcome of the Steel Strike, the market on this commodity is somewhat stronger and the manufacturers are asking $110.00 per ton on the 78-80 per cent article, delivered; while the British Maker is quoting $100.00 per ton, c.i.f. Tidewater.

Ferro Silicon. Makers are looking for a figure of $85.00 per ton; but a tonnage may be purchased for $80.00, or slightly under.

Fire Brick. The English markets is higher than quoted in the last review and standard 9x4½x2½", best quality, is quoted at 197/6 per thousand, and the second grade at 182/6 per thousand, f.o.b. Liverpool and Glasgow. American Fire Brick, best quality, are bringing $36.00 to $41.00 per thousand, and $30.00 to $35.00 per thousand for second quality, f.o.b. Pennsylvania points. Silica Brick are quoted at $40.50 to $45.00 per thousand for best quality, and Magnesite Brick $80.00 to $85.00 per ton (2000 lbs.) f.o.b. Pennsylvania points.

Fluorspar. There has been no change in the price of this article and Flourspar containing 73-78 per cent Calcium Fluoride is quoted at 22/ to 24/ per ton, f.o.b. English ports. The Canadian Fluorspar, containing 85 per cent Calcium Fluoride, is quoted at $25.00 per ton delivered.

Copper. With the decrease in exports for the month of September, which is considerably lower than for the month of August, and in view of the uncertainty of labor conditions, the market on Copper is somewhat weak and quotations of 24½c. per lb. ex warehouse f.o.b. Montreal are quoted.

Tin. Price of 56c. per lb. f.o.b. Montreal.

Zinc Spelter. Dealers are asking 9¾c. per lb. for this article, f.o.b. Montreal.

Antimony. Price of $9.75 per 100 lbs. f.o.b. Montreal.

Pig Lead. The market on Pig Lead has advanced and quotation is now 7-⅝c. per lb. f.o.b. ex warehouse, Montreal.

Pig Iron. There has been an advance in the American market of $2.00 per ton, and Canadian prices are based on Buffalo quotations, for No. 2 ex foundry at $31.00 per ton, f.o.b. Buffalo.

Cast Tool Steel. Price f.o.b. Montreal 16c. per lb.

High Speed Tool Steel. Makers are asking $1.50 per lb. f.o.b. Montreal.

Heavy Melted Scrap. Little interest is manifest in this material and the prices are practically the same as quoted last month: Heavy Melting is selling at $12.00 to $14.00 per ton. C. I. Car Wheels bringing $20.00 to $22.00 per ton. Steel Rails, in assorted lengths, $17.00 to $18.00 per ton. Turnings and Borings selling for $5.50 to $6.50 per ton. All f.o.b. point of shipment.

Lake Superior Ores. 51½ per cent Non-Bessemer Ore is quoted at $5.55 to $5.70 per ton, f.o.b. shipping point.

Calcined Magnesite. Price in the neighborhood of $45.00 per ton delivered.

Ingot Moulds. American quotations f.o.b. shipping point are approximately $40.00 per net ton (2000 lbs.)

Coke Oven By-Products. While the output of these materials will be affected by the Steel Strike, yet the prices as recently received are: Sulphate of Ammonia $3.40 to $3.75 per 100 lbs. Pure Benzol 25c to 30c. per 100 lbs. f.o.b. American Makers plants.

Business in general is fairly active. Want of supplies of raw material is hampering some of the manufacturers; but the smaller lines are running at capacity, and the textile manufacturers and makers of boots and shoes are booked for some months ahead.

All indications show that the Steel Strike is practically over. The fact that the Manufacturers are operating at 75-80 per cent capacity indicates that the back bone of the strike has been broken. The evidence of Judge Gary before the Keynon Committee and the withdrawal of the Labor Committee from the Labor Convention at Washington has only strengthened the public sentiment which was so evident before the investigation. There is a strong public feeling against permitting the foreign elements among the labor classes to dictate to the country. It is stated the American mills are booked for some months on merchant bars, hoop steel, nails and other more refined products. This should be reflected in a brightening of the Canadian steel market.

The coal situation at present is very serious. The production of the United States is some sixty or seventy million tons behind last year, and with the logical reduction which must follow the strike, it would not be surprising if Canadian firms who have bought the American article will have difficulty in securing the tonnage covered by contract. Although the American Fuel Controller has stated that Canada will secure a pro rata share of the output, we are somewhat sceptical as to whether they will have the capacity to do so. The strike of the Longshoremen in New York, followed by the strike of the miners, should be of a considerable benefit to the port of Halifax, and in fact it has already benefitted to a considerable extent. The larger passenger boats have been calling in at that place for some days for bunkers and if the strike continues for any lengthy period, this trade will mean a brisk winter for the City of Halifax.

The Victory Loan in Canada is now in full swing and the Government will, no doubt, be successful in obtaining their objective. The circulation of some three hundred millions should mean that Canadian business conditions will be excellent for the next few months.

Too late for inclusion in our advertising pages we learn that the Canadian Kron Scale Company has removed its premises to 16, Notre-Dame Street, East, Montreal.

It is announced that a combination of Montreal and Toronto plants using large quantities of oxygen has been formed to manufacture oxygen in Toronto, and that $1,200,000 out of an authorised capital of $2,000,000 has been privately subscribed without any public offering of stock.

Sulphur in Coal*

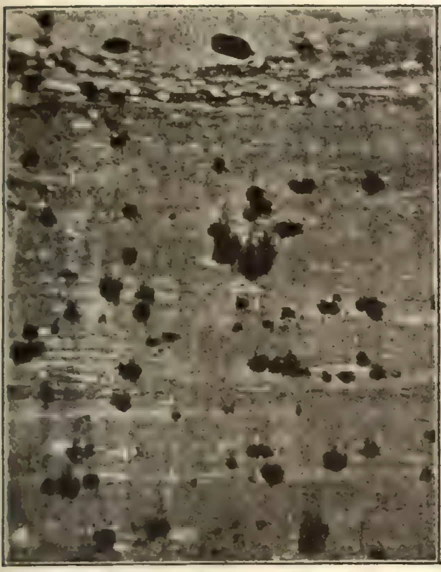


Fig. 1.

Fig. 2.

Fig. 1,—Thin cross section of coal from Vandalia mine No. 82, near Terre Haute, Ind., No. 5 bed, showing a thin layer of anthraxylous coal with numerous microscopic pyrite globules. Pyrite globules are shown black as irregular roughly rounded areas. Many have been partly broken and fragments, consisting of minute cubes, have been dragged to some distance over the section. Anthraxylon is that part of coal derived from parts of logs, stems, branches, or roots. × 100.

Fig. 2.—Thin cross-section of coal from Vandalia mine No. 82, near Terre Haute, Ind., from No. 5 bed, showing layer of dull coal containing numerous thin strips of anthraxylon embedded in an attritus or debris. Black, roughly round areas represent microscopic pyrite grains; white irregular strips represent cuticles; and short linear patches represent spores. Tendency of pyrite globules is to form rows along thin strips of anthraxylon. Attritus is that part of coal derived from all sorts of macerated plant parts and plant products. × 100.

Reference was made in our editorial columns in the October issue to the very interesting symposium on sulphur in coal that took place at the Chicago meeting of the A. I. M. & M. E., and while a full reproduction of Dr. Reinhardt Thiessen's paper on this subject would probably not be desirable in a periodical that is prepared for persons who are more concerned in the uses of coal than with its origin or production, a condensation of Dr. Thiessen's treatise, with a reproduction of the microscopic sections on which his conclusions were mainly based, may be not improperly included.

Dr. Thiessen mentioned the better known, and grosser forms of sulphur occurrence in coal, in the form of balls, lenses, nodules, continuous layers, thin sheets and flakes occurring both in the horizontal planes and in the vertical cleavage fissures of coal as it lays in the seam. But pyrites also occur in very fine microscopic particles, disseminated or powdered throughout the compact coal. This form of pyrite occurrence has had little consideration.

All the coals examined by Dr. Thiessen contained a varying amount of sulphur in very small globules, or particles, of pyrite. Their minute size is best appreciated by comparing the illustrations accompanying, in which they are shown at a magnification of 100 diameters, which is equivalent to stating that the entire field covered by the individual slides represents actually a section of coal as large as the ordinary period used in print. The streaked appearance of the globules of pyrite is due to their breaking into innumerable cubical fragments in the process of cutting the section, which distorts the dots of pyrite to some extent.

The amount of pyrite in this form varies considerably in different beds from which coals have been examined, and also in different samples from the same bed, or even in different parts of the same microscopic section. No coal section examined has been found did not contain pyrite particles, but no regularity of occurrence has been noticed.

The largest number of the pyrite globules is found in that part of the coal believed to be derived from the woody parts of plants.

Sulphur is an essential element in almost all proteins, which are essential to living organisms, and as coal is derived

Fig. 3.

Fig. 4.

Fig. 3.—Thin cross-section of coal from La Salle, Ill., showing a layer of anthraxylous coal, including a number of pyrite globules. × 100.

Fig. 4.—Thin cross-section of coal from Sesser, Ill., No. 6 bed, showing pyrite globules in dull coal, which here is composed of thin strips of anthraxylon and attritus; the latter includes spores, shown white. × 100.

Fig. 5.—Thin cross-section of coal from Shelbyville, Shelby Co., Ill. Pyrite globules are distributed through whole section; here and there, several have joined and others have coalesced. Globules are somewhat smaller than in other sections shown. × 100.

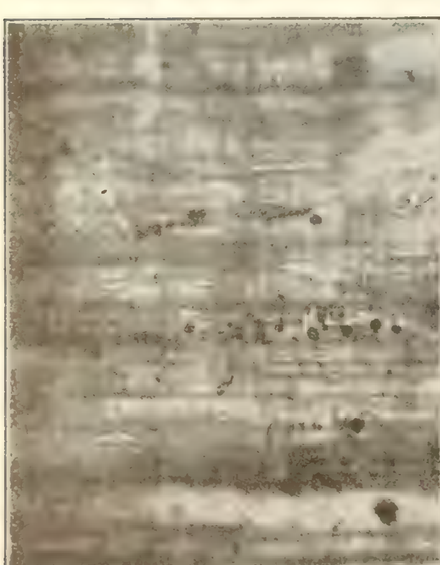
Fig. 6.—Thin cross-section of coal from Sipsey mine of Black Creek bed, Ala. Some of pyrite globules have coalesced into lenticular masses; smaller globules are distributed through whole section. × 100.

Fig. 5. Fig 6.

Fig. 7.—Thin cross-section of sub-bituminous coal from Stone Canyon, Contra Costa Co., Calif. Coal shown consists of rather finely macerated woody matter, including resinous particles and cuticles, besides pyrite globules, shown in black. × 100.

Fig. 8.—Thin cross-section of lignite from Montana. Section shown consists of macerated woody matter and other plant debris, including some spore and cuticular matter. Only two pyrite globules are shown. × 100.

Fig. 7. Fig. 8.



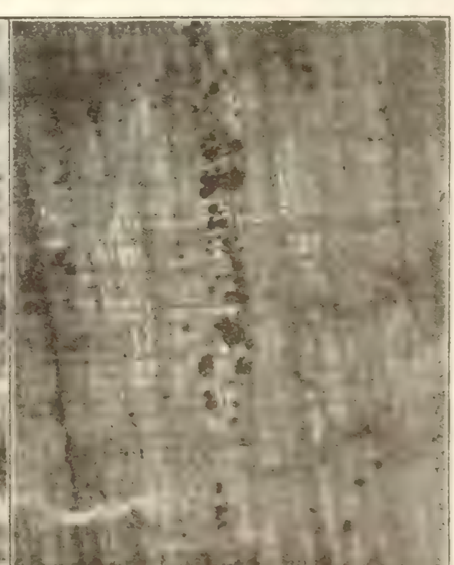


Fig. 9.—Thin section of woody peat, taken from peat bog near Hayton, Wis. Black dots represent pyrite globules lodged in wood fibers; several have been broken into minute cubical fragments. × 100.

Fig. 10.—Thin section of woody peat taken from peat bog near Hayton, Wis., showing considerable number of pyrite globules lodged in wood fibers. It will be noticed that they are strung out in cavities of wood fibers.

Fig. 9. Fig. 10.

from vegetation, it must contain at least as much sulphur as the substances from which it has been formed. This form of sulphur is not microscopically distinguishable, and is usually referred to as organically combined sulphur. Regarding this form of sulphur Dr. Thiessen says it has received much scientific attention but has not been sufficiently recognised on the economic side.

Non-protein sulphur exists in plants, and is particularly large in quantity in such odoriferous plants as onion, garlic and mustard, while in some wood ashes it is found up to 3.7 per cent in the case of white pine. Dr. Thiessen notes that the amount of sulphur in plant ashes is not a true index of the quantity present in the plant material, as a certain amount escapes in the burning.

Sulphur is found in all peats, and the process of growth of new and living organisms in the peat bog on top of the residue of plant growth that preceded them, causes a concentration of sulphur in the peat, which is found to contain by actual trial from 0.29 to 4.21 of sulphur. If therefore in the conversion of peat to coal a reduction to one-tenth of the original mass is assumed to have taken place, with no loss of sulphur, then the resultant coal would contain from 2.9 to 42.1 per cent of sulphur. There is therefore more than enough sulphur in peat to account for all the sulphur in coal.

Dr. Thiessen makes more interesting speculations on the part which is played by sulphur bacteria in reducing sulphur to a form in which it can be used by plants, but his remarks are in this respect extremely technical, and moreover the knowledge of the chemical reactions caused by these bacterial organisms is not exactly known today, so that no exact analogy can be drawn with what may have occurred in the age of coal deposition.

Dr. Thiessen's reasoning bears entirely on the form of disseminated sulphur shown in the slides, which he assumes, for the reasons mentioned, to have had a primary origin, and is found in coal today because it is a prime constitutent of the vegetation from which coal is formed.

The grosser forms of sulphur, such as balls, lenses and the large sheets of marcasite that occur in some coals, may have a secondary origin.

Dr. Thiessen's paper would appear to suggest that the "sink and float" test of the sulphur carrying elements in coal, preliminary to installing washing devices for the reduction of sulphur, might be usefully supplemented by microscopic examination of the coal.

F. W. G.

*Abstracted from a paper by Dr. Reinhardt Thiessen on "Occurrence and Origin of Finely Disseminated Sulphur Compounds in Coal", published by permission of Dirctor, U. S. Bureau of Mines, and read before the A. I. M. & M. E. Chicago, Sept. 1919.

PLASTIC ARC WELDING IN SHIP REPAIR AND CONSTRUCTION OF SHIPS.

By J. O. SMITH.*

The successful repair of the German merchant fleet interned in American harbors, after having been damaged by its crews beyond the possibility of mending by ordinary processes, was readily accomplished by the Plastic Arc method of electric welding. It is now suggested that the same process may be employed in the construction of new vessels with a saving of both time and material. Claim is also made for a marked gain in strength.

Plastic-arc welding, which was employed in repairing the German ships which had been damaged by their crews, had been in use and under development on a large Eastern railroad for a long time previous to the outbreak of war in 1917, and it was the results achieved by it in welding heavy cast iron locomotive and other parts that caused the Navy Department engineers to turn to it as a means of repair in the case of the damaged German ships.

The repairing of these ships by arc-welding marked an epoch in the affairs of men, in that it brought into practical use a branch of the electrical industry which had, up to that time, never been employed on so extensive a scale or with the same incentive. The successful repair of the large cast iron cylinders and other parts of the Germans ships has led naturally to consideration of arc-welding in the manufacture and repair of metal products and parts of all kinds. The attention of engineers generally has been attracted by its possibilities, and the great achievement of successfully repairing the damaged ships has naturally given the subject great prestige among shipping and shipbuilding interests.

* Wilson Welder & Metals Co., Inc., New York.

When the matter of welding in connection with ship construction is considered, immense possibilities immediately suggest themselves. It has been definitely determined by exhaustive technical study and experiment that welding can be satisfactorily employed in ship construction, that ship plates joined by welding will be as strong, or stronger than the original metal, at the welded joint, and that welding can be employed for ship construction work at a saving of 25 per cent in time and 10 per cent in material, as compared to riveting.

In actual figures, as determined by experiments of the Emergency Fleet Corporation's electric welding committee it was determined that by welding in the case of a 9,500 ton ship, the saving in rivets and overlapped plates would amount in weight to 500 tons,

Miscellaneous Welded Ship Scantlings.

making it possible for the ship to carry 500 tons more cargo on each trip than would be possible if the ship plates, etc., had been riveted, instead of welded.

Investigation by this committee has definitely established the following points:

That electric welded ships can be built at least as strong as riveted ships.

That plans for ships designed to be riveted can easily be modified so as to adapt them for extensive electric welding, and thus considerably save in cost and time for hull construction.

That ships especially designed for electric welding can be built at a saving of 25 per cent over present methods and in less time.

An electrically welded ship is credited with many advantages over a riveted ship. In a 5,000 ton ship about 450,000 rivets are used. A 9,500 deadweight ton ship requires 600,000 or 700,000 rivets. By welding process the saving in labor on the minor parts of a ship is reckoned at from 60 to 70 per cent, while on the hull plating and other vital parts, the saving in labor, cost and time of construction by welding is conservatively placed at 25 per cent.

That electric welding will some day largely replace riveting is also the judgment of the committee, which is composed of 82 of the leading experts

Considerable investigation of the subject of welding instead of riveting has been made in England by Lloyds Register of Shipping particularly with regard to formulating rules for application to the electrical welding of ships. As a result of the investigations and experiments made by the Society's technical staff, it was determined that the matter had assumed such importance as to warrant the formulation of provisional rules for electrically welded vessels, and these have been issued for the guidance of shipbuilders by Lloyds Register.

The experiments conducted in England followed three well defined lines of investigation. Determination of ultimate strength of welded points, together with their ductile properties; capability of welding joints to withstand alternating tensile and compressive stresses, such as are regularly experienced by ships, and microscopic and metallurgical analyses to determine if a sound fusion was affected between the original and added metal.

It was determined that the tensile strength of the welded joints was from 90 to 95 per cent of the original plates, as against strength of from 65 to 70 per cent in riveted points, showing a margin of 25 per cent increased strength in favor of the welded joints.

The result of the tests of the elastic properties of welded points determined that there was a slight difference in favor of the riveted joint, but the art of welding has made such great strides recently that it is now believed entirely possible to make a welded joint in ship plates that will stand as great a number of reversals of stresses as a riveted joint.

Microscopic and metallurgical analyses have determined definitely that a good, solid, mechanically sound weld was made between the original and the added metal, the two metals having been fused together so perfectly that no line of demarcation could be seen.

The rules so far promulgated by Lloyds have been necssarily of a tentative nature and will no doubt be modified and enlarged from time to time in view of the experience that will be gained after a few welded ships have been in service for a time.

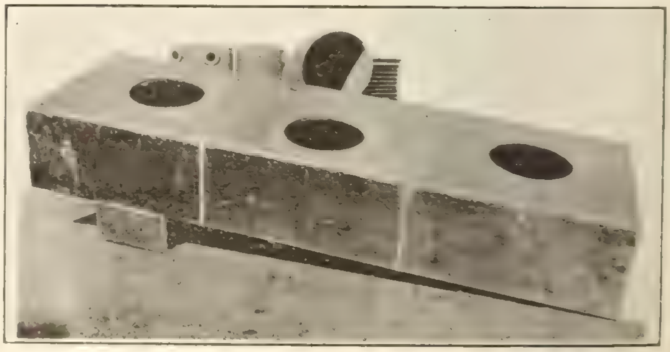
It does not require a great deal of imagination, however, to enable anyone to form the opinion that the ship-building industry is on the eve of great modifications in constructional lines, and the guidance given the shipbuilding industry by the tests and comparisons so far made will undoubtedly lead to important, radical departures and developments in the industry.

In addition to the increased cost of riveting as compared to welding it is practically always true that there are a certain percentage of imperfectly fitted rivets that have done nothing more than add weight to the ship. The main purpose of a rivet, of course, is to bind two or more thicknesses of plate together, but if the rivet is bent, loses part of its head in the riveting process, or otherwise fails in its proper purpose, there is no method by which such faults can be corrected after the rivet cools. It must be removed entirely if the importance of the riveting part requires a perfect joint, and this is frequently a time-killing, expensive course to follow. When it is considered that a 5,000 ton ship requires approximately 450,000 rivets to bind the various parts and plates and also that a certain percentage of these rivets are not fulfilling the purpose for which they were put into the ship, it is quite evident that practically every ship it is quite evident that practically every ship is burdened with a good sized load dead, useless weight. Such defective rivets are in fact more than a useless weight, in that they are a menace to the ship, for while they have been built into the ship for a purpose, and are supposed to be fulfilling that purpose, there is no telling how much the ship has been weakened structurally by their failure.

There are many reasons for defective rivets, and one of the greatest of them is inaccessibility, and consequent difficulty on the part of the riveter in putting the rivets properly in place. Another reason is that there is no certainty that rivets are at a proper, workable temperature, in consequence of which if they are too cold the pneumatic hammer now generally used in riveting is unable to round off the end of the rivet properly, so as to insure a proper binding together of the plates the rivet is supposed to hold.

In many cases, when such leaky rivets are discovered, the present day method is to weld such defective spots, which immediately brings up the natural question as to why the plates should not be welded in the first place.

The ability of a welder, using a direct-current, low-voltage arc with automatically regulated current to make sound mechanical welds in cramped, confined spaces, on overhead or vertical walls, in fact, anywhere a man and a wire can go, naturally suggests that welding ship plates together should be the primary operation in shipbuilding, and from present indicatioins and the trend of current events, it seems more than likely that this will be the outcome in the near future.— "Shipping" New York.



Fuel Oil Tanks for Destroyers. Welded throughout.

EDITORIAL

The Possibility of Creating An Iron and Steel Industry in the Canadian West

At the recent meeting of the Canadian Mining Institute a lively interest was manifested in the long debated subject of the possibility of an iron and steel industry in the Province of British Columbia. The Editor of this periodical was asked to start the discussion, and believes that the question is one of sufficient national importance to warrant the inclusion in the editorial column of a series of remarks which were, in effect, a review of the history of the iron and steel industry of Nova Scotia presented in such form that British Columbian auditors could make their own deductions on the analogies which exist between the extreme East and the extreme West of Canada in this connection.

The genesis of a successful iron and steel industry in Cape Breton Island came about through the presence of large deposits of coal, suitable for the manufacture of metallurgical coke, close to an excellent harbour, favourably situated with regard to world markets, near large deposits of limestone and dolomite, and within easy transportation distance of the unique iron-ore deposit of Wabana, Newfoundland. It may here be remarked that even the people of the East have not quite grasped the valuable and illimitable character of the Wabana deposit.

Coal had been mined in Cape Breton for seventy years, but the industry was backward. Winters of idleness, and Summers of rush and hurry to obtain the largest possible outputs, made for unsatisfactory labour conditions, general instability and lack of progress. The resources of Cape Breton lay dormant until a man of vision in the person of Mr. B. F. Pearson collected facts and figures and presented them so convincingly as to interest Mr. H. M. Whitney, with whose advent into Cape Breton there commenced those consolidations of scattered coal properties and the influx of capital which made possible the coal and steel industry of Cape Breton as it exists today. Many undesirable happenings mark the Sydney "boom," but, whatever may have been the shortcomings of those days, the result has proved there is a legitimate place for the "entrepreneur," for the promoter of industrial enterprises who has vision and faith—but—before the promoter must come the careful compiler of commercial facts, who must demonstrate from the results of painful research and the slow accumulation of uninteresting but essential facts and figures that a sound basis exists upon which to found the projected industry. That the reward of the man who digs the foundation is often less than the reward of those who come after him seems to be one of life's ironies that must be accepted.

The lesson taught by events in Cape Breton and elsewhere, is that a steel industry is an outgrowth of the presence of coal.

The founders of the Cape Breton coal and steel industries appreciated the vital importance of transportation, and they provided large fleets of modern freighters.

Events have also showed that neither the steel companies nor the coal companies of Cape Breton are entirely self-supporting. One is the complement of the other. The underlying stability of the coal companies has enabled the steel companies to take advantage of periods of prosperity in the steel industry, the monetary results of which, in their turn, have greatly helped the coal companies.

The lesson that appears to be deducible from these gradual developments is that the most successful and permanent combination of industry is that of an associated industry of iron and steel manufacture, with steel-ship building, both based on large reserves of coal, iron-ore and fluxes, having a suitable maritime location.

If actual events in the East seem to be foreshowing the completion of such an evolution it should not be any matter for surprise, as such combinations have proved successful elsewhere.

In the application of this conclusion to British Columbian conditions, it is worthy of note that the technical conditions existing in Cape Breton were always most favorable, and such as might be expected to bring about cheap costs of operation. Nevertheless, the problems of the iron and steel industry have always been those of competitive markets and relative wages.

British Columbia has imperfectly known iron ore deposits, but sufficient is ascertained concerning these deposits to show that they are large and valuable. The maritime and strategic location exists on either the mainland coast or on Vancouver Island, but most important of all considerations is the existence of coking coal on Vancouver Island.

The analogy between the relative position of the iron ore deposit of Wabana and Cape Breton Island, and

the position of Vancouver Island to the known iron ore deposits of British Columbia is very exact, even to the existence of large deposits of undersea coal on the extreme east and west coasts of Canada.

Fuel costs are basic in the steel and iron industries. The problem of iron smelting and steel manufacture is chiefly that of providing great heat supply at a low cost.

The possession of large deposits of coking coal of metallurgical grade is British Columbia's chief industrial asset.

It is questionable whether the people of the West realise the tremendous concentration of the fuel resources of Canada in the two western provinces of Alberta and British Columbia. The map which is attached to the Final Report of the Fuel Controller shows that Alberta alone contains more coal than all the rest of Canada put together, and also contains more coal than any single State in the American Union, besides being a vast potential oil reserve.

Empire and national growth follow the possession (and the utilization) of coal, and where coal and iron exists by the side of the sea, wherever true British stock is to be found they must fulfil the maritime destiny of our associated British peoples. It is the way of the race. The future of coal, iron and shipbuilding on the British Columbia coast is not a purely local question. It is far wider in its implications, and imperial in its scope.

The considerations affecting a future iron and steel industry are primarily two, viz.,

a. Technical questions;

b. Economic and social questions.

Economic problems come first in importance. If a real necessity exists for the manufacture of iron and steel in British Columbia, the technical problems present no insuperable obstacle.

Dr. Stansfield's Report on the manufacture of pig-iron from B. C. magnetites by use of the electric furnace is full, complete and authoritative, but it must be borne in mind that Dr. Stansfield reported as a professor of metallurgy, on certain set questions, and not as a promoter, and that since his report was made the knowledge of B.C. iron ore resources has been enlarged. Dr. Stansfield's report is the document which will most interest capitalists with serious intentions.

The iron industry of British Columbia—which the future is quite likely to see—should not require aid from new and untried processes. It can, as Dr. Stansfield pointed out, be operated with complete technical success by using the ordinary and accepted methods of metallurgy which have been profitably employed elsewhere.

There is no necessity, and it would be a grave mistake, to be misled by unconfirmed reports of secret processes by which magnetite ore can be converted into steel by the electric furnace.

The economic problems resolve themselves into the question of a market. This should be made the subject of a careful statistical survey of local consumption of iron and steel, and the consumption in that territory over which a British Columbia plant could compete, which should include Alberta, the Yukon, Alaska, and the north-western States.

As to an export market, there would appear to be a good opening on the coast of South America, and while China will some day become the world's greatest producer of coal and iron, yet for the life of this generation, and maybe for fifty years, she should provide a market for pig-iron and steel products.

All these things will require to be compiled with exactness, and made ready for presentation to investors in a form suitable for study.

The social problems include the availability of suitable labour. An iron and steel industry requires a large number of unskilled labourers, and a smaller number of expert workmen, and there will be associated with the provision of these necessary workmen large questions of transportation and housing.

There is another feature. Capital today is very timid, and it has reason to be. Before investors will find large sums of money for an iron or steel plant in British Columbia, substantial guarantees of safe investment must be given, and the social evolution of the province must include the fostering and protection of invested capital.

From the experience in the East, the things which should be avoided in commencing an iron or steel industry include the following:

a. An unnecessarily large initial capital expenditure.

b. The establishment of a plant of a character too greatly in advance of local markets.

c. A plant of an unbalanced character, requiring orders representing a large tonnage of one product in order to keep running.

4d. Too great reliance on subsidies. Subsidies, wihle necessary perhaps in the initial stages of a new industry, should not be regarded as part of the permanent income of any enterprise.

These may seem elementary statements, but in the East they have been taught by painfully acquired experience.

At the recent annual meeting of Sir W. G. Armstrong, Whitworth & Co., held in London, the Chairman, Mr. J. M. Falkner, said, in the course of his remarks:

"We have no choice before us in these days of progress except to develop and develop again. This is "essentially an age of big things, and particularly of "big industrial combinations, when every company "tries to associate itself with another company in order "to become self-contained and self-supporting."

Mr. Falkner's remarks have a very general application.

By-Product Coke Ovens

In this issue of "Iron and Steel" will be found a description of the new coke-oven plant of the Dominion Iron & Steel Company at Sydney, Nova Scotia. This plant is without doubt as fine an installation as any in North America. It contains all the modern features of coke-oven practice, namely, narrow oven-chamber, short coking time, large yield of coke and by-products, and labor-saving devices wherever possible.

It has been stated by a competent authority that 35 hundredweight of coal for each ton of pig-iron produced, coked in modern ovens, using the coke produced in the blast furnace and utilising to the fullest extent the gases evolved from the coke-ovens and the blast furnace, should be sufficient not only to provide the heat for the smelting process in the blast furnace, but also sufficient heat for converting the pig-iron into steel and for re-heating and rolling the steel ingots into some commercial shape.

This ideal has not yet been realised, but that it should be put forward as practicable, is a welcome indication that the trade is commencing to realise how all important is the fuel factor in the iron and steel industry.

In Canada, the by-product plants of the steel companies were never in such good order, nor were they ever so capable of producing large coke outputs.

In the United States, the percentage of by-product coke now exceeds the tonnage made in bee-hive ovens.

In Great Britain, during the war, 1,750 coke ovens were built, at a cost of $25,000,000, to which the Government contributed some six million dollars. It is expected that as a result of these new ovens the by-product coke output in Britain would exceed the pre-war output by fifty per cent. All over the world a steadily increasing percentage of the coal output is being subjected to coking processes, with recovery of by-products, which foreshadows the day, not so very far distant, when no coal will be burnt without recovery of the by-products.

The Trade Outlook

From the standpoint of the Canadian producers of iron and steel, the trade outlook is distinctly brighter than it was, and the anticipated revival of demand in the late Autumn has been to an appreciable extent realized.

Since the November issue appeared orders have accumulated in sufficient volume to enable the steel plants in Nova Scotia to look forward to a winter of fair activity.

In Ontario the two large steel companies report business as encouraging. The reflex of the steel strike in the United States is being felt in the increased demand for steel in Canada, but there is much reason to believe that the reduction of iron and steel production which has been attributable to the strike of the steel workers is a less important matter than the reduction which is taking place and will still further take place from the strike of the bituminous coal workers. The increase in wages—whether it be small or great—which seems certain to come in the wages of United States coal workers will have the most important effect of all present happenings upon the position of the Canadian producers of iron and steel, as it will increase the cost of production of iron and steel in United States plants in a ratio which will be quite surprising when its full effect becomes manifest. The United States has in the past been favoured with coal at a cheaper price and in more plentiful supply than any other industrial and civilized country, and its predominance in population, national wealth and industrial output is in large part built on a foundation of good, cheap and plentiful coal supply. The favourable nature of the exchange markets to United States funds is also largely to be attributed to the same cause. The United States is about to experience something of what older countries have already experienced, inasmuch as coal-mining in the United States has now entered upon an entirely new phase. A very significant announcement of recent times is that twenty million tons of coal in the United States was in the last fiscal year produced from seams of coal three feet and under in thickness. While the United States need not fear any coal shortage for centuries to come, yet appreciable inroads have been made upon the thicker and more cheaply accessible seams of coal, and in the future the cost of coal production in the United States will steadily advance, first from physical reasons, and secondly because of the contraction of hours of work and increased wages paid to miners, which in their turn will increase all costs of material used in the extraction of coal—notably coal consumed at colliery fires—and will still further increase the cost of coal production. The everlasting pyramiding of all manufacturing and transportation costs by increasing the initial cost of mining coal is a thing that the public, and its parliamentary leaders seem unable to grasp. Be that as it may, the increase in the cost of fuel at the United States steel plants is about to increase the cost of steel production, probably not to the disadvantage of Canadian producers.

The position of Canadian users of iron and steel, largely bought in the United States, is not so favourable, and it appears as if they might be given an opportunity to buy materials in Canada itself, which will not be an unmitigated evil.

The lesson which Canada is now being taught of our country's deplorably subservient position in regard to

supplies of coal, iron and steel, and our exchange rate will, if one may seek to interpret the independence of the Canadian spirit as it is usually accepted and believed in, do more to stimulate our native production of coal, iron, and gold—all of which we are plentifully supplied with—than millions of government subsidies. We are not as a nation economically independent. It may be assumed that Canada has no intention of becoming politically subservient to the United States, but there is no escape from the implication that we must be either one or the other.

We import far more coal than is mined in Canada Our own coal industry has declined while that of the United States has sky-rocketed in an extraordinary manner. Only five per cent of the iron-ore smelted in Canada is mined there. Our currency is at a humiliating discount in New York. The absolute necessity of these conditions is not admitted, and Canada could and should occupy a more independent position in connection with the basic materials of coal ond iron than she now possesses.

The New Interests In Dominion Steel

The cabled reports from England regarding the plans of those who have recently purchased an interest in the Dominion Steel Corporation, read very strangely. The Dominion Steel Corporation, in popular rumor, has been amalgamated successively with the Steel Company of Canada, the Nova Scotia Steel & Coal Company, the Halifax Shipyards, the Canada Steamship Lines, and now we have included the Century Coal Company, whose business is the sale of United States coal in Canada.

So far, all that can be ascertained from the official reports is that British interests have taken 50,000 shares of treasury stock—which in itself represents ten per cent of the consolidated capital of the Dominion Steel Corporation. This is about the same amount as the loan which was made to the Dominion Steel Corporation by Speyer & Co. some years ago, secured by short term notes, and now completely paid off.

In the latest cable despatch, appearing in the Montreal "Gazette" of the 10th December, Colonel Grant Morden is reported as saying that British engineers, after a complete survey of the Steel Plant have reported in favor of "scrapping nearly all of it." as it was very out of date, and they recommend the installation of a new plant at a cost of between "two and three million pounds."

One hardly knows what to make of such irresponsible statements. No new steel plant can be built for "two or three million pounds." Further, the Dominion Steel Company has just put its plant in very good shape, and the only really weak link in the plant is the rather out-of-date and inadequate open-hearth plant. The blast furnaces are in good condition. The coke ovens and washery are new, and the best of their kind, and it must be a cold douche to trusting, not to say credulous, holders of steel stock to hear that after spending so many millions on the extension and rehabilitation of the steel plant, that it "is very much out-of-date," and should be "nearly all scrapped."

The place where the Dominion Steel Corporation now needs to spend money is not on its steel plant (which is in better shape than it ever was in its history), but on the collieries, on which practically nothing has been expended since 1912.

The "Gazette" report also mentions that the British interest in Dominion Steel is $35,000.000, when actually it is officially reported to be $3.500.000.

Really, both coal and steel shareholders are entitled to more responsible statements from the newspapers. and if the shareholders of the Dominion Steel Corporation are not tired of seeing their company and interests made the football of ridiculous rumor, and lying at the mercy of nebulous schemes which take no account of sober fact, they should be.

The Dominion Steel Corporation has made lots of steel in the past, and good steel. Why should it be thought proper for British engineers, or any other kind of engineers, to inspect a going plant, which recently made a lot of money, and nonchalantly announce that the aforesaid plant is a junk pile? It is a wonder the term a "streak of rust" was not used. It is a favorite expression of outside engineers when inspecting Canadian steel plants.

If the Dominion Steel shareholders presently wake up and ask who is running their affairs it will not be surprising.

THE CONVOY PORTS OF HALIFAX AND SYDNEY

"World's Work" for December contains the first of a series of articles by Rear Admiral Sims, U. S. Navy, in which are contained some interesting references to the use of Sydney and Halifax, Nova Scotia, as ports of assembly and departure for merchant-ship convoys.

To those whose good fortune it was to witness the periodical gathering of the fleets of dazzle-painted ships in Sydney Harbor and Bedford Basin, Admiral Sims' recital will call up interesting memories, and it is worthy of note that during nearly five years of war the shipping of coal and steel proceeded virtually without interruption.

As Admiral Sims states, once the convoy system was properly organized the arrival and departure of the convoying warships proceeded with the regularity of a train service.

The Dominion Iron and Steel Company's Koppers By-Product Coke Plant at Sydney, N.S.

By C. E. Wallin, Superintendent of Coke Oven Dept.

During 1916 it became evident that the coke plant of the Dominion Iron & Steel Co. at Sydney, would be taxed to its utmost to provide sufficient coke for the Blast Furnaces then in operation, and furthermore the small size of the ovens on the plant first erected and the method of handling the coke after quenching would always militate against the production of coke at a cost which would compare favorably with coke made in more modern plants.

The importance and necessity from an economic standpoint of recovering the greatest possible percentage of by-products has been so often emphasised, notably in recent articles in this journal by Messrs. Marquard and Lucas, that there is no occasion to touch further on this phase of the subject.

To obtain a plant embodying the latest improvements in by-product operation and labour saving machinery, a contract was placed with H. Kopper's Co. of Pittsburg for the erection of two batteries of 60 ovens each, and work was commenced on the site by the By-Product Coke Company of Canada Ltd, in the spring of 1917. Construction was delayed owing to difficulty in obtaining delivery of materials but, even so, the first battery was put in operation on Oct. 12th, 1918 and the second on March 27th of the present year.

The Coal carbonized is 100% high volatile slack coal from the Dominion Coal Coy's mines and has in the raw state the following average analysis.

	Per Cent.
Volatile Matter	33.50
Fixed Carbon	57.50
Ash	9.00
Sulphur	2.50

Before being delivered to the ovens the coal is first crushed in a Jeffries roll crusher and then passed through a British Baum Washer, of 150 long tons per hour capacity, to lower the ash and sulphur contents. On its passage to the crusher the coal is screened to eliminate the fines which by-pass the crusher and mix with the crushed coal at the foot of the elevator.

The coal leaving the washer has a moisture content of approximately 11% and the following analysis calculated on a dry basis:

	Per Cent.
Volatile Matter	34.50
Fixed Carbon	60.50
Ash	5.00
Sulphur	1.60

The washed coal is delivered on to a 36″ belt conveyor and delivered to the oven bin which has a capacity of 2200 net tons of coal and is situated above and midway between both batteries.

The ovens are of the standard Koppers regenerative type and of the following dimensions.

Length between door brick	37′ 6″
Width on pusher side	15¾″
Width on Coke side	18¼″
Height from floor to top of coal	8′ 7″

and have a capacity of 11.3 tons of coal weighing 49 lbs. to the cubic foot, but the density of the coal varies somewhat owing to varying moisture content of the washed coal and percentage of fines in the slack supplied.

The batteries consist of sixty ovens each, Fig 1. each oven having independent regenerators, thus constituting a separate unit. Heating is effected by the combustion of a part of the gas generated during carbonisation, the gas being supplied alternately to the pusher and coke sides of the ovens. The gas is supplied to the 16 vertical flues on the pusher side and 14 on the coke side by means of a hollow gun brick running the entire length of the oven and having outlets on top. These outlets are fitted with nozzle brick with an elliptical orifice at which point combustion of the gas takes place. The size of this orifice varies with the position of the nozzle brick along the gun brick, the size increasing from the second nozzle on either side to the division wall of the battery to make allowance for the drop in pressure and increase in temperature of the gas during its passage through the gun brick. The largest nozzle is in the outside flue on each side on account of the large amount of heat lost through radiation at the doors. The volume of gas supplied to each battery for heating purposes is measured by 16″ x 8″ indicating and recording Venturi meters.

The necessary air for combustion is drawn, by the stack draft, through the regenerator on the side on which the gas is burning; and in doing so becomes heated to approximately 1800°F. From the regenerator it passes into the vertical flues alongside the gas nozzles. The amount of air admitted to each individual regenerator is regulated by dampers on the air box, the damper for the oven furthest away from the stack having naturally the widest opening. This makes it possible to equalise the draft conditions on each oven. A further adjustment can be obtained by altering the size of the opening, where the vertical flue joins the horizontal flue, by means of a sliding brick.

Each vertical flue can be inspected from the top of the battery by the removal of a cast iron cap and it is possible in this way to take the temperatures of the flues, examine the state of the nozzle brick and change the same if necessary, make adjustment of the sliding brick settings and generally keep a close check on the conditions under which the combustion of the gas is taking place.

The advantages to be gained from this system of oven heating are the close adjustments of gas and air with the result that the oven walls are evenly heated by the minimum amount of fuel gas. The gas is reversed every half hour, or twenty minutes in cases where extremely high flue temperatures are carried.

All the operations of reversal are carried out by means of a master control which shuts off the gas on one side, reverses the stack dampers and air openings and finally open the gas cocks on the opposite side. This control is put into operation by means of a self-winding clock which makes certain electrical connections every half hour or twenty minutes as the case may be.

Fig 1. General View of the Coke Ovens of the Dominion Iron & Steel Company at Sydney, Nova Scotia, showing in foreground the Koppers Ovens, Coal Pocket, Larry and Coke Sidings; and, in the distance, Sydney Harbor.

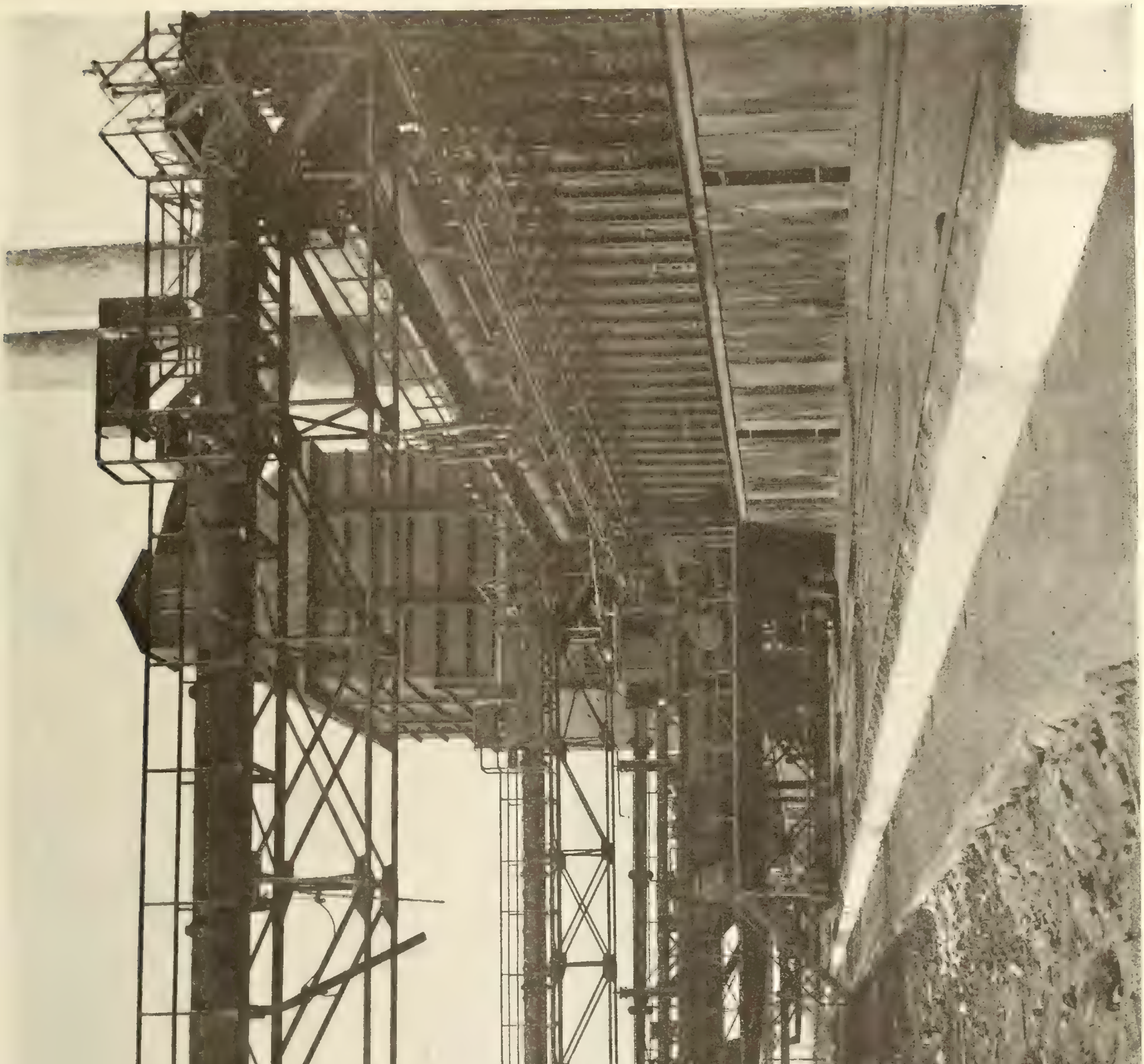


Fig. 2. Pusher Side of Ovens, showing Pusher and Pusher Track, and the Cross-over and Suction Pipe Mains.

The products of combustion are carried away by side flues running the length of the battery to a stack 7' 6'' in diameter and 200 feet high.

The coal is charged into the ovens from a larry equipped with four hoppers and a sufficient quantity of coal is drawn from the oven bin into these hoppers to fill the oven to the proper level. This level is regulated so as to allow contact of the gas with the heated brickwork for as short a time as possible.

After the coal is discharged from the larry into the oven, it is levelled off, the charging covers placed in position and luted down and the oven connected to the collecting main by opening a butterfly valve. Under these conditions a charge of coal can be carbonised in 18 hours, with an average flue temperature of 2470°F. The ovens are designed for a coking period of 15½-16½ hours but with a washed coal containing 11% moisture it is not deemed advisable to raise the flue temperature to the height necessary to accomplish this.

At the end of the coking period the oven is cut off the main, the doors removed by door machines on either side of the battery, and the charge of coke is pushed out into a wide dumping car of steel and cast iron construction. The car is then brought by an electric locomotive to the quenching station where the coke is subjected to a spray of water for 35—40 seconds. After draining in the car for five minutes it is discharged on to the coke wharf, the power for elevating the dumping doors being provided by an air compressor on the electric locomotive. The coke contains on an average 1.5% moisture. Figs 2, 3 and 4.

From the wharf the coke is fed into a belt conveyor which delivers it on to a ¾'' bar grizzley screen, the furnace coke and breeze being delivered direct into cars down their respective chutes. Fig 5.

The collecting main on the ovens is connected by two crossover mains to the suction main from the batteries. It is important to carry as constant a pressure as possible on the collecting main and to ensure this each crossover is fitted with a governing device known as a North Western governor. A float controlled by the gas pressure in the collecting main is set to give in the neutral position the desired pressure and any variation in the position of the float caused by a rise or fall in presure actuates a lever making electrical contact in the power circuit of a small reversing motor. The motor in turn opens or closes a butterfly valve allowing more or less gas to pass from the collecting main until the lever attains the neutral position and breaks the contact. Only one governor on each battery is in operation, the other acting as a spare.

The suction mains from both batteries unite in a common downcomer outside the by-product building.

In order to keep all mains clear of pitch which, if not removed, would eventually block the mains, a flush of hot tar and gas liquor is kept in circulation by

Locomotive and Coke quenching Car, showing a chrge of coke being pushed out of the oven-chamber.
Fig. 3.

means of a centrifugal pump, the solid matter bieng filtered off by suitable screens.

The gas entering the by-product building is first cooled by passing through a multitubular cooler, gas and water entering at opposite ends; the gas passing around the tubes and the water through them.

The gas temperature at the exit of the coolers is determined and kept constant by the automatic Tagliabue temperature control operating, by means of compressed air, a motor valve on the inlet water line By this means the gas is cooled down to 28°C at which temperature most of the lighter tar and water vapour is deposited and carried away to the hot drain tank to be used as a flush in the mains as mentioned above.

The gas is drawn away from the ovens by a Root's exhauster with a capacity of 700,000 cu. ft. per hour and capable of exerting a pressure of 3½ lbs., the exhauster is driven by a 20½" x 24" Fleming Engine operating at a pressure of 100 lbs, per sq. in. The engine is equipped with piston valves, the cut off being regulated by a Root's gas governor which keeps a constant suction on the main by varying the speed of the engine to deal with varying volumes of gas. In passing through the exhauster the gas is heated up to 35°C and is then led through a Tar extractor where the last traces of tar are eliminated and flow to the hot drain tank with the tar from the primary coolers. Fig. 6

The gas is next passed through a tubular reheater, and its temperature raised to 60°C by the exhaust steam from the engines, and then to the Saurator which is a cylindrical cast iron vessel lined with lead. The hot gas is carried down a vertical lead pipe inside the saturator, into a horizontal cracker pipe also of lead. The cracker pipe is of inverted U section and is slotted with vertical semi-elliptical holes through which the gas passes.

The Saturator contains a solution of Ammonia Sulphate with 7% free Sulphuric Acid and the ammonia in the gas, in passing through this bath, combines with the Sulphuric Acid forming Ammonia Sulphate, which crystallises out and is continually ejected by a compressed air syphon on to the drain table, the mother liquor flowing back again to the saturator. A continuous addition of Sulphuric Acid is made to the saturator, the amount being run in being determined by the operator who tests the free acid content of the bath at intervals of half an hour. Fig. 7.

The sulphate from the drain table is flushed in to a centrifugal dryer where it is washed with hot water and finally whizzed for ten minutes at 600 revolutions per minute. The finished sulphate averages .2% free acid and 1.5—2.% moisture and is a good white colour.

The By-Product house is equipped with three complete interchangeable sets of engines and exhausters, tar extractors, reheaters and saturators, each being capable of dealing with gas from 60 ovens, so that there is always one spare set available in case of breakdown.

Quenching a charge of coke. Coke-wharf on the right.

Fig. 4.

The ammonia condensed from the gas as gas liquor contains 50% of the total ammonia and after running in to the hot drain tank with the tar, is pumped into a settling tank where the liquor settles on the top of the tar and liquor and tar are then run off into separate storage tanks. The tar thus obtained conains 2% moisture.

The gas liquor is fed into a 6' 0" ammonia still having free and fixed stills on separate foundations, the lime necessary to decompose the ammonia salts is introduced into the bottom section of the free still, and steam for the operation is furnished by the exhaust steam from the engines at 15 pounds pressure. The flow of liquor is measured by means of a Venturi meter, 3,000 gallons per hour has been successfully treated with a loss of .015 grams per litre of ammonia in the waste liquor.

The gas liquor contains 8.2 grams per litre of total ammonia of which 75% is in the fixed state.

The ammonia vapour generated is led through a covered pipe which is connected to the main gas line between reheater and saturator.

The top temperature of the still is kept constant at 99° except for 1 hour at the end of each shift when it is raised to 103°C. and at the same time the acid content of the saturator is increased. This prevents the cracker pipe and saturator becoming salted up and blocking the passage of the gas.

After leaving the saturator the gas passes through an acid separator where the traces of acid mother liquor carried by the gas are deposited, and thence to the final cooler. The cooler consists of a steel tower 60' 0" high and 12' 0" in diameter containing sets of wooden grids. Th gas in its upward passage meets a descending spray of water, the cooling being accompanied by a partial deposition of naphthalene. The temperature of the gas is here reduced from 60°C to approximately 20°C., the latter temperature depending on the temperature of the cooling water, but no difficulty has been experienced in cooling the gas, if necessary, to within three degrees of the temperature of the water as shown at the inlet to the cooler.

After being cooled the gas passes through two towers of similar design to the final cooler, but 100' 0" high and 15' 0" in diameter. Here it is washed with a high boiling point petroleum oil which absorbs the Benzol vapours from the gas, 95% of the total Benzol being absorbed with suitable conditions of gas and oil temperatures and oil flow.

The debenzolised gas is then passed to a holder of 40,000 cu. ft. capacity. From the holder it is delivered to the fuel mains at the batteries and the surplus gas is measured by an indicating and recording it is sent under pressure to the steel plant. The surplus gas is measured by a nindicating and recording Venturi meter. Should it be necessary, at any time, to cut off the supply of surplus gas at the steel plant, the holder, when full, automatically opens a valve on

Loading Coke and Breeze Simultaneously

Fig.

the bleeder line and discharges the surplus gas into the atmosphere.

The gas has the following average analysis:—

	Per Cent.
Carbon dioxide	2.0
Illuminants	3.5
Oxygen	.5
Carbon Monoxide	7.0
Methane	31.5
Hydrogen	48.5
Nitrogen	7.0

The Benzolised oil is pumped to the Benzol Plant and there stripped of the Benzol and its homologues and the cooled debenzolised oil returned to be again circulated through the towers.

No description of the Benzol Plant is given as it does not form part of the Kopper's installation, but it may be stated that Benzol, Toloul, Xylol, and Solvent Naphtha of the highest degree of purity have been produced in large quantities, notably during the period of the war.

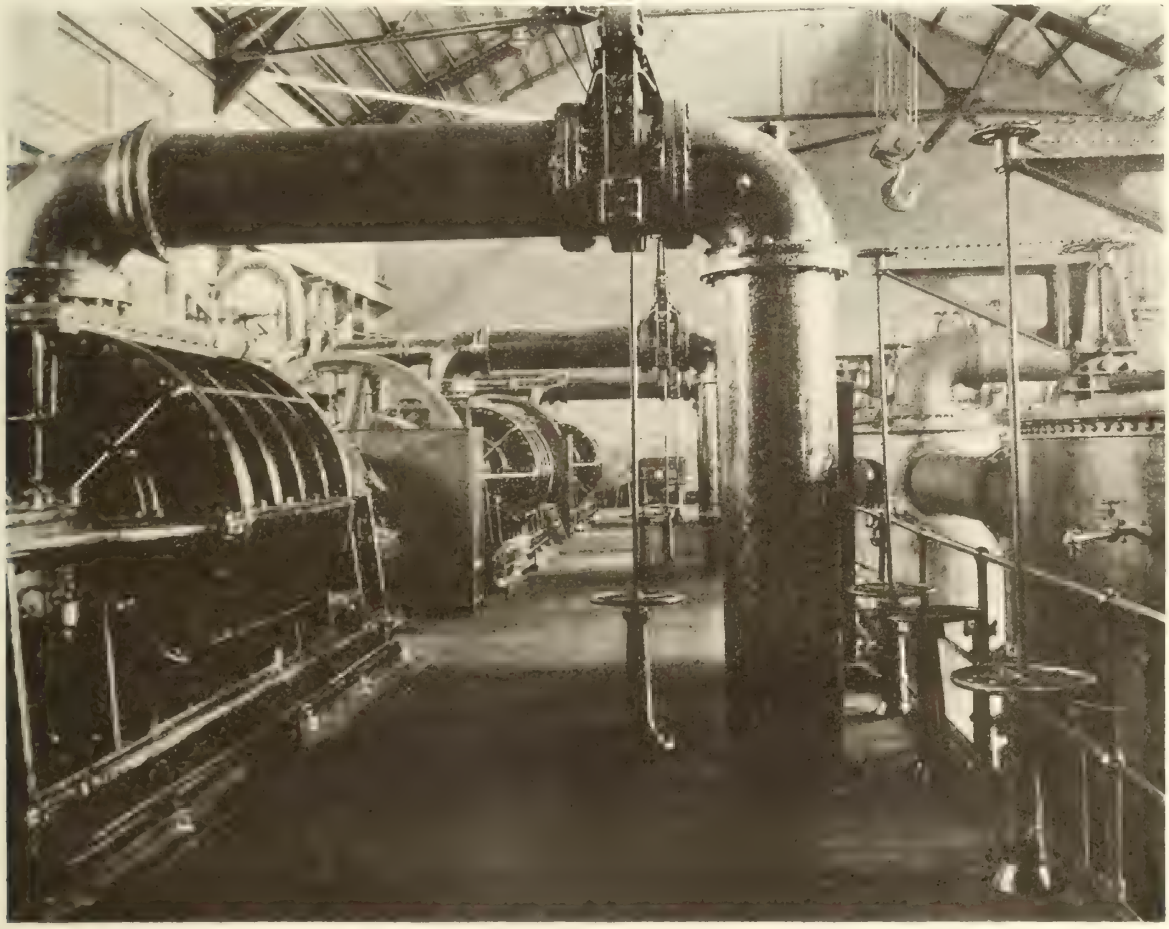
Below are given some operating statistics which may be of some interest.

	m.m. water
Suction after primary coolers	175
" before " "	85
Pressure on collecting mains	3.5
Stack draft	21.0
	cu. ft.
Gas Consumed—	
On ovens per hr. Pusher side	180,000
On ovens per hr. Coke side	170,000
Percentage of total gas	40%

Production (Short tons.)

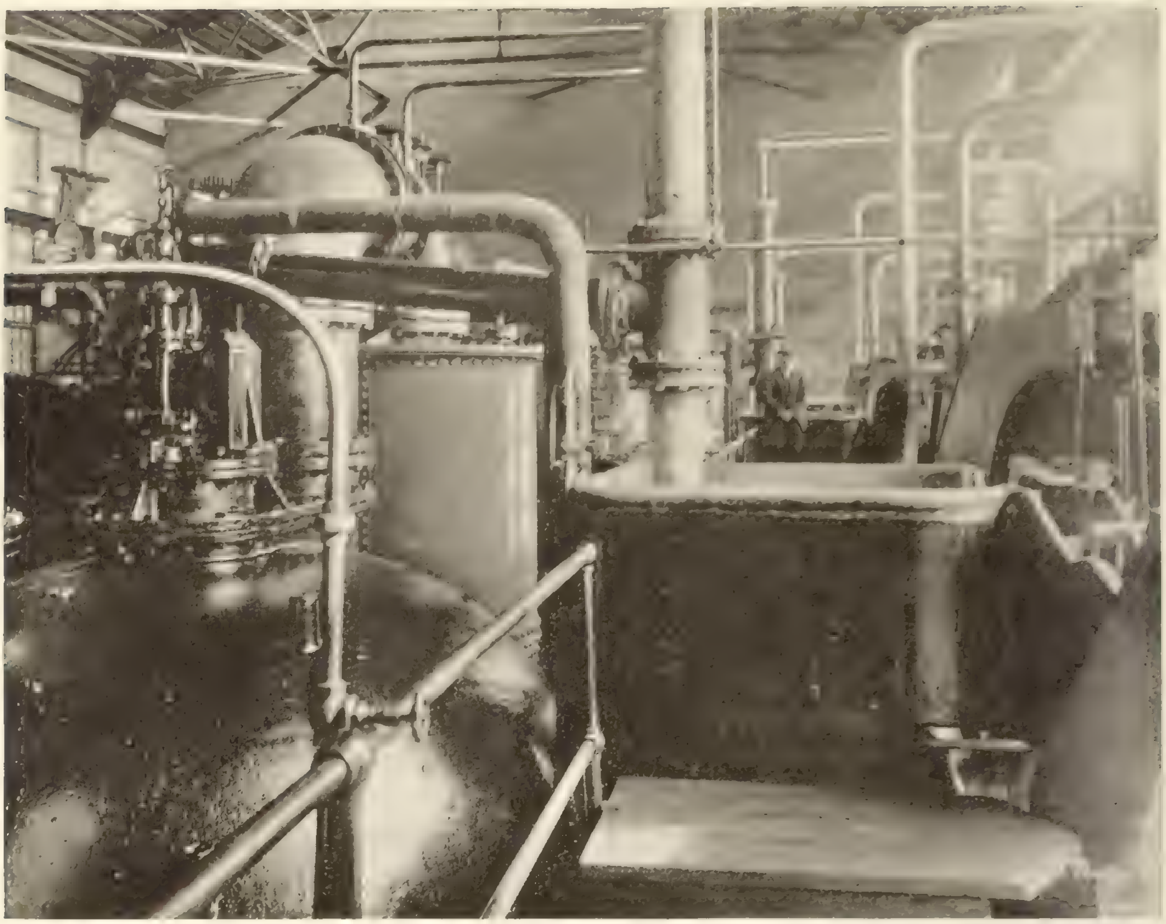
	Per ton dry coal	Per 24 hrs.
Furnace Coke (lbs.)	1360	1180*
Surplus Gas (cu. ft.)	6300	10,987,000
Tar (Imp. Gal.)	11.0	19,000
Ammonium Sulphate (lbs.)	28.0	24.4*
Ammonium Sulphate loss in Saturators and Stills (lbs.)	.086	150
Light Oil (Imp. Gal.)	2.9	4800
Coal charged per oven		11.0*

* Tons.



Interior of By-Product House, showing Engines and Gas Exhausters.

Fig. 6.



By-Product Building, showing portion of apparatus for making Sulphate of Ammonia, including Saturator, Acid Separator, and Drain Table.

Fig. 7.

General View of Coke Oven Installation, Dominion Iron and S teel Co., Sydney. Coxheath Mtn., seen in the distance, is site of deposit of decomposed feldspar used as fireclay—see p. 271, November issue.

By-Product Plant and Buildings of Dominion Iron and Steel Company's Coke Oven Installation at Sydney, Nova Scotia

OUR MARITIME LETTER

Ferro Managanese.—This market has firmed up considerably since our last letter. The American price asked is in the neighborhood of $125.00 per ton, C.I.F. Canadian points. This increase is, no doubt, due to higher price on pig iron, probable coal shortage and scarcity of labor. Some English manufacturers are quoting £26 to £27 per ton, C.I.F. Canadian points.

Ferro Silicon.—Higher figures have not been obtained on this material; but it will no doubt have a sympathetic advance with Ferro Manganese. The sellers are looking for higher prices and we are inclined to think they will obtain them. The asking price is $85.00 per ton, F.O.B., shipping point.

Fire Brick.—Prices on Fire Brick remain unchanged, and the English market is quoted at 197s 6d per thousand for first quality Standard 9 in., and 182s 6d for second grade stock, F.O.B. Liverpool and Glasgow. American quotations remain as quoted, $36.00 to $41.00 for first quality 9 in. and $30.00 to $35.00 for second quality. Silica brick are bringing $40.50 to $45.00 per ton, for best quality; Magnesite brick $80.00 to $85.00 per ton. All F.O.B. Pennsylvania points.

Fluorspar.—No changes are recorded over last month's quotations and flourspar with 73 to 75 per cent calcium fluoride is quoted at 22s to 24s per ton, F.O.B. English port. Canadian fluorspar is bringing $25.00 delivered.

Copper.—The market on copper has fallen considerably and the foreign and domestic demands are such that we may look for a lower figure shortly. With the companies only operating about fifty per cent capacity and the average cost of production being in the vicinity of 16¼c per pound, it is possible the operators will endeavour to stimulate the market by reducing prices. Lake Copper is now quoted 23c ex store, Montreal. American figures are 19s F.O.B. New York, for Prime Lake.

Tin.—The English market has developed some strength, although the American market is not so strong. Quotations are now 59c ex store, Montreal.

Zinc Spelter.—Dealers are asking a price of 10c ex store, Montreal.

Antimony.—There is a slight advance on this material and price is now 11c ex store, Montreal.

Pig Lead.—Canadian prices are slightly lower than last quoted, and the quotation is 7c per pound, ex store, Montreal.

Pig Iron.—The American market on pig iron has been very strong, no doubt partially caused by the reversion of coal prices to those obtaining during the war, and No. 2 ex Foundry is now quoted at $36.00 to $37.00 F.O.B. Furnace. It is not at all improbable that further advances will be made in the near future. Iron has been sold well up into 1920, and it is very probable that higher prices will be recorded shortly.

Cast Tool Steel.—16c per pound, F.O.B. Montreal.

High Speed Tool Steel.—We are quoted the English article at 3s 9d per 100 lbs. for 18 per cent tungsten. The Montreal sellers are asking $1.50; but sales will be limited at this figure, when the direct importation price is so much lower.

Heavy Melting Scrap.—Since our last letter, the American market has advanced considerably; but as yet it has not been reflected in Nova Scotia and prices are as follows:

	Per Gross Ton.
Heavy Melting	$12.00 — $14.00
Cast Iron Car Wheels	20.00 — 22.00
Rails	14.00 — 15.00
Turnings and Borings	5.50 — 6.00

Lake Superior Open Hearth Lump Iron Ore.—Lump ore averaging 59 per cent metallic iron is being sold at $5.55 per ton, F.O.B. shipping point.

Calcined Magnesite.—45.00 per ton delivered. Indications are that higher figures will obtain on this material shortly.

Ingot Moulds.—The English quotations is 320s per ton (2240 lbs.) F.O.B. tidewater.

Brattice Cloth.—The severe storms in India and difficulties in transportation have stiffened the market very materially and prices asked are approximately 13d per square yard for fireproof and 11d per square yard for tarred brattice, F.O.B. English ports.

Wire Rope.—There has been an advance in the English prices; but at this writing no details are at hand.

Coke Oven By-Products.—The only advance recorded has been in spot sulphate, which is now quoted at $3.55 to $3.80 per 100 lbs., at United States Producers' plants. Pure benzol remains at 25c to 29c per gallon.

Coal.—As pointed out in previous issue, the scarcity of American coal for the Canadian market is already felt. The output of American bituminous mined to the 25th October, 1918, was 493,000,000 tons and for the same period of this year the figures are 391,000,000, making a shortage of 102,000,000 tons. Since the inception of the strike, on November 1st, the production has been cut from 10,000,000 to 12,000,000 tons per week to approximately 2,000,000 tons per week, so that the shortage is being increased from 8,000,000 to 10,000,000 tons per week. The American coal situation is a very serious one, and it would seem that the Government will find that it is quite one thing to issue an injunction and prevent a strike; it is quite another proposition to make the individual miner go into the mine and mine coal. We wonder what would happen if the American Government were to give the miner his own medicine and prevent him getting coal for his personal use and from obtaining employment in other industries, unless he agrees to get back to pre-strike output. It has already been intimated that there is a possibility of Canadian railways being obliged to take off some of their trains, unless the situation becomes easier. Exportation of coal has been prohibited, except by license; but this will hardly be exercised in the bunker trade. The bunkering trade in Halifax has been very brisk. The Dominion Coal Company are working to capacity. The Nova Scotia Steel & Coal Company have recently purchased two large barges and equipped them with cranes, which will insure bunker trade having the quickest possible despatch.

Steel Prices.—The United States Corporation have not advanced their prices, nor are they likely to do so for some little time. However, some of the smaller independent companies have not been so lenient and with the demand for delivery, their prices have been advanced quite considerably. The American steel strike is every day becoming more obscure in the returning of strikers under protection of the Government; but some of the plants are not yet working at anything like capacity.

COMPANY NOTES

The plant of John T. Hepburn, Limited, 18 Van Horne street, Toronto, has been completely reorganized and rearranged of late, the firm having closed up its plant at 47 Davis Street and moved it up to its present premises. The firm have purchased the business of the Martin Pump and Machine Company and have started pump manufacturing on a considerable scale. They are now turning out boilers, feed, vacuum and power pumps and small engines, cranes winches, derricks and gear and castings of all kinds. With the installation of standard equipment and the rearrangement of its plant the firm is now in a position to handle their increasing business on a much greater scale. One of the company's specialties is the Hepburn heavy duty high speed planer which is now being constructed at the plant in its entirety.

The Hamilton Gear and Machine Company, Toronto, is planning on reopening that part of the plant that was devoted to the manufacture of tractors but which was discontinued some months ago owing to adverse tariff conditions. The department will probably be devoted to one of the company's other lines.

The Norton Company of Worcester, Mass., have bought a site in Hamilton, Ont., and are getting out plans for a plant for the manufacture of grinding wheels for use in steel plants. The Canadian company is capitalized at $500,000.

The Dominion Steel Metal Corporation have just completed a new warehouse at their plant in Hamilton, Ont., at a cost of about $30,000. The product of the company is galvanized iron.

Hamilton, Ont.—The Dominion Canners, Ltd., have purchased a site of six acres in extent in the east end of this city. It is stated that the company intend to erect a $1,000,000 plant.

London, Ont.—The London Life Insurance Co., has announced that it will begin the erection of a new office building next year at a cost of more than half a million dollars.

London, Ont.—Contract let to Hyatt Bros. for the erection of a $200,000 addition to the plant of the McClary Manufacturing Co.

Fort William, Ont.—It is stated that the C.P.R. Co. will submit a proposition to the city council which involves something like $2,000,000 in the erection of a railway hotel in this city. It is understood that if the proposition is submitted it will be voted on by the ratepayers at the January elections.

Belleville, Ont.—The Chemical Products Corporation, Ltd., Toronto, propose to spend about a million dollars on the construction of a plant here.

Brantford, Ont.—A permit for the erection of a factory for Robbins and Meyers, in the Holmedale district, Brantford, has been applied for. The cost of the new building is estimated at $150,000, and the dimensions are 80 ft. by 411 ft.

Bridgeburg, Ont.—The Brazil Motors Co. of Brazil, Indiana, a $2,000,000 industry, is looking for a site for the establishment of a Canadian plant. Both Bridgeburg and Welland are being considered.

Stratford, Ont.—The Canadian General Electric Co. has purchased the Mooney buildings in this city, and will remodel same and install new machinery for the manufacture of electrical appliances.

Peterboro, Ont.—The city commissioners have accepted the tender of the Dominion Bridge Co. for the supply of steel for the new telephone building. The amount involved is $18,290, being 148 tons of steel at $123.58 per ton. It is expected that the contract for the construction of the building will be awarded to J. Dunlop at $80,468.

Windsor, Ont.—The Auto Specialties Co. have commenced building operations on their 10½-acre site in this city. Their first unit will involve one large and three small buildings, having a total floor space of about 50,000 square ft. When completed and equipped this unit will represent an investment of fully $200,000. The plant will eventually cover the entire site. Work on the second unit will commence next summer. The construction contract is in the hands of S. E. Dinsmore & Co. The Canadian Bridge Co. are erecting the steel, and J. C. Pennington is associate architect with Davidson & Weiss, of Chicago.

Windsor, Ont.—Tenders will be received up to November 29th for the erection of the new $400,000 public school. Architect, A. H. McPhail.

Victoria, B.C.—Contract for the construction and erection of a steel viaduct over Deep Creek, on the P.G.E. Ry., seventeen miles north of Williams Lake, has been let by the government to the Canadian Bridge Co., of Walkerville, Ont., at $330,000, this bid being the lowest of four received. The highest bid was $401,000. The viaduct will have a span of 1,160 ft. from abutment to abutment, and will be 300 ft. in height. Some four million pounds of steel will be required.

Victoria, B.C.—The provincial government has granted certificates of incorporation to the Canadian Water Wheel Co., Ltd., Vancouver, capitalized at $100,000, and the Campbell Rotary Pump Co., Ltd., Vancouver, also with a capital stock of $100,000.

A nine-ton hammer, an oil furnace, and another oxy-acetylene welder have been added to the equipment of the Victoria Machinery Depot blacksmith shop, Victoria, B.C., which was recently enlarged by an addition measuring 36 by 40 feet. The old steam hammer in the shop delivers a blow of three tons, while the new one is the largest in the city. The blacksmith shop is now one of the finest on the Island. There are twenty-five men now employed there.

A visit to the V.M.D. plant showed much activity. From eight to ten boilers, several of which are 72 by 18, are being constructed. They are all for Island lumber mills.

At a meeting of the director of the Pressed Metals Company, Limited, held in Toronto this week, the following names were added to the directorate: Benjamine Lowenstein, president, Nassau Smelting and Refining Company, New York; Morris Moskin, of Moskin Brothers, New York; Edward Hay, late general manager of the Imperial Bank; W. R. Johnston of Toronto, and Eugene Coste, E.M., of Calgary. The board now consists of Messrs. C. E. Calvert, president; J. W. Leighton, vice president; Simon Goldsmith, of New York; H. L. Nussbaum, of Toronto; J. R. L. Starr,

K.C., of Toronto, together with the above mentioned gentlemen. Further plans for the financing of the American plant of the company were considered at the meeting and it is said that they are well under way. The talk on the street was of plans for a new stock issue, with this end in view, but there was no announcement to this effect.

The recently completed extension to the Belmont foundry at Indianapolis of the Link-Belt Company virtually consists in completing the company's new furnace buildings, Nos 7 and 8. For the present the company will install only furnace No. 7, which will be 15 ton capacity instead of 10 ton like the present furnace. The company is also purchasing the necessary machinery such as rollings mills, sand blast and other foundry equipment needed to take care of the additional capacity. The building when completed will be about 70 feet wide by 400 feet long and will complete the foundry as originally laid out.

Sandwich, Ont.—The Fisher- Foundry Co. proposes to build a $200,000 factory here.

Toronto, Ont.—The works committee approved the plans of the General Fire Extinguisher Co. for a factory on Dundas St. Approximate cost, $500,000.

Hamilton, Ont.—The International Plow Works Co. will erect a $100,000 extension to its present large plant.

Hamilton, Ont.—The United Aircraft Engineering Corporation of New York has offered to erect and operate a municipal airdrome if the city will provide a site.

Winnipeg, Man.—Work on a new 110,000-volt transmission cable, to run from the Winnipeg power plant at Point du Bois, Man., parallel to the present cable, will be started immediately and completed before November, 1920, according to an announcement made by J. G. Glassco, manager of the city power and light department. The new line will cost the city $750,000. Extension to the city office, 54 King. St., and to the power plant on the Winnipeg River will bring the total to be spent on improvements to $1,270,000.

Dartsmouth, N.S.—Imperial Oil Co. plans to enlarge its refinery here very shortly. An expenditure of approximately $1,000,000 will be involved in connection with the work. Chief engineer, Thos. Montgomery, 56 Church St., Toronto.

Boynton & Williams, dealers in contractors' supplies, have moved to new and larger offices and warerooms at 42 Lombard Street, Toronto. George P. Beswick, secretary of the Purchasing Agents' Association, and for twenty years with the Polson Iron Works, Toronto, has been appointed office manager and purchasing agent of the Boynton & Williams organization. At the new warehouse a large stock of pipe, valves and fittings is being carried. The firm also acts as representatives for a number of American manufacturers, and deals in new and used machinery.

Galt. Ont.—Work has started on a 142 by 32 ft. extension to the machine shop, and 44 by 26 ft. addition to the moulding shop of the Perfect Machinery Co. Brick construction.

Excavation work is well advanced for the extension which the Steel Company of Canada, Limited, are making to their bolt and nut building. This extension will provide an additional floor space of 60,600 sq. ft. The extra accommodation will be used partly for storage and shipping and partly to enlarge the facilities for the various manufacturing processes. The estimated cost of the work is $200,000. The new building will be four stories high, of reinforced concrete construction. F. G. Peden, of Montreal, is the architect, and the Anglin-Norcross Co., Ltd., of Montreal, have the general contract.

Niagara Falls, Ont.—Under the name of the Niagara Wire Weaving Co., the Lindsay Wire Weaving Co., of Cleveland, Ohio, is spending $220,000 on the erection of a plant here.

Hamilton, Ont.—A permit for an extensive four-story addition to the factory of the B. Greening Wire Co., Napier Street, has been issued to W. H. Yates. Estimated cost, $40,000.

Vancouver, B.C.—There will be an expenditure of $600,000 made by the Imperial Oil Co. for the plant of Ioco, on Burrard Inlet. The extensions include additions to the treating plants, acid restoring plants, and refinery.

London, Ont.—Building permit issued to the McClary Mfg. Co., for erection of a three-story shop building, 61 by 183 ft., on Adelaide Street. Estimated cost, $55,600.

That there is a steady demand for all products in the stove and enamelware industry in Canada is the conviction of A. M. Smith, Sales Manager of the McClary Manufacturing Company of London, Ont. The production of Canadian plants is not at present, but may be in the not distant future, influenced by the amount of steel that can be secured from the mills. The producers do not hold out too great hopes for an early return to normal shipments. So far as the stove manufacturers are concerned, they are not believed to be in immediate danger of running short of supplies. Mr. Smith's investigations in Great Britain, earlier in the present year, convinced him that there is a wide market for the products of Canadian stove-makers. So far as Europe is concerned, there is the drawback that the types of stoves in general use are quite different from those produced in Canada which, of course reduces the chances of doing business with the Continent.

The present shareholders of the National Steel Car Company of Hamilton, Ont., will hand their stock, common and preferred, to the new company that will operate the plant. They are to be allowed 19,000 shares in the new concern, valued at $1,250,000. It has not been decided as yet how the new shares are to be allotted. A meeting of shareholders will be held shortly, when new officers will be elected and the shares will be divided. In the meantime the old officials will carry on, according to the announcement of Thomas O Scott, the secretary-treasurer.

It is announced from Belleville that A. P. Gillies, on behalf of the Tivani Electric Steel Company of that city, and allied interests, has applied to the Hydro-Electric Power Commission for quotations on a supply of 50,000 horse-power, to be delivered at its proposed

steel plant to be erected presumably at Belleville. New York mining and engineering experts have visited Belleville and North Hastings the past week. They looked over the various iron ore deposits in Tudor and Wollaston townships, and have been favorably impressed with the immense ore bodies there awaiting development.

The Booth Electric Furnace Co., whose incorporation was announced in these columns a few weeks ago, has opened up the following district offices in connection with the sale of electric furnaces for melting steel, iron, and non-ferrous metals. For New York and New England, Edward B. Stott & Company, Flatiron Building, New York City, with Mr. E. P. Tweedy, Secretary of the company, directly in charge; for Eastern Pennsylvania, New Jersey, Maryland, Delaware and Southern Atlantic Coast states, Northern Engineering Company, 306 Chestnut Street, Philadelphia, with Mr. F. W. Doran in charge; for Northeastern Ohio, western Pennsylvania, and Western New York State, Mr. Chas. L. Foster, formerly Sales Manager of the Electric Furnace Company, of Alliance, Ohio, with offices at 879 The Arcade, Cleveland, Ohio. In connection with these district offices a complete staff of engineers and metallurgists will be maintained so that the needs of customers can be promptly met and adequately taken care of. Further announcements will be made of the opening of other district offices, arrangements for which are being completed.

The De Long Hook and Eye Company, a branch of a large American concern, have decided to instal a plant at Woodstock, Ont., for the manufacture of hooks and eyes. The parent concern are manufacturers of many iron and steel products. The Woodstock branch will employ from fifteen to twenty hands at the start.

The big programme of development under way at the iron plant of Baldwins Limited, in Toronto, make it obvious that the production of heavy steel castings and drop forgings will be a natural line along which to expand. The present plant site on Ashbridges Bay, together with additional lands under option, is sufficiently large to permit of extension plans of considerable magnitude. It is suggestive that vessels of 24 feet draught can find dockage accommodation in the ship channel: it is also noteworthy that plans are under consideration for the canalization of the St. Lawrence. The realization of the accessibility of the Great Lakes to ocean vessels may be in the future. This would make it possible to carry on export trade and to bring in iron ore cargoes from the Atlantic seaboard. The management of Baldwins consider that the use of coal as fuel is too costly for the rolling mills under present conditions. Either electric power or fuel oil will be employed in the rolling mills. While the phases of manufacture employed in the present plans are important, they do not exhaust the field of possibilities in connection with an industry of this kind. The company look forward to transacting export business. Much of this may be to Great Britain, in steel products that can be made more enonomically in Canada. The consumpcion of large quantities of scrap will be guaranteed through the operation of the electric furnaces in the production of steel sheets, which will provide a domestic as well as the present export market.

The MacKinnon Steel Co., Limited, of Sherbrooke, Quebec, has been awarded the contract for the steel superstructure of the highway bridge which the Government of the Province of Quebec has arranged to erect over the Batiscan River, at Batiscan, Que., on the Montreal-Quebec highway. This bridge, which is over twelve hundred feet long, will be one of the largest highway bridges in the Province of Quebec.

The Ottawa Car Manufacturing Company, Limited, are erecting a new brass foundry on Slater Street, Ottawa, in close proximity to their main plant. Construction work is well under way and when completed this foundry will be one of the most up-to-date in Canada. The main building of the foundry is 50 ft. by 112 ft. with extra buildings for coke storage, metal storage and so forth. This extension was made necessary on account of the rapid growth in this firm's business. Mr. T. Ahearn is president, W. Y. Soper vice-president, W. M. Arnold general manager, and W. H. Inglis, who has had many years experience with several of the largest foundries on the continent, is superintendent of their foundry.

PRESIDENT STAYS WITH LOCOMOTIVE CO.

At a meeting of the Board of Directors of the Canadian Locomotive Company held in Toronto on Nov. 4th, President F. G. Wallace was persuaded to retain his position with the company and was given six months leave of absence. This effectively sets at rest the rumor that another company might take control following Mr. Wallace's departure but there is apparently nothing of that nature contemplated. The following official statement was given out: "A meeting of the directors of the Canadian Locomotive Company was held in Toronto today for the purpose of taking action upon the resignation tendered by Mr. F. G. Wallace, president of the company. The board unanimously insisted on Mr. Wallace retaining office, granting him a six months leave of absence, which he has accepted. This arrangement would indicate that no outsider will be brought into the company, and it is probable that Mr. Wallace will leave the affairs of the company in the hands of Mr. William Casey, general manager."

OXYGEN TO BE MADE IN TORONTO.

An indication of the wide and increasing market for oxygen for use in welding and other industrial processes is given by the incorporation of the National Electro-Products Company in Toronto. The directors of the new company are President, W. J. Cluff, of the Canada Pipe and Steel Company, Toronto; vice-president, H. W. Beauclaire, of Montreal; directors, W. W. Near, president of the Page Hersey Iron and Tube Co., Ltd., Toronto; R. J. Cluff, Toronto; A. McDougall, Toronto; G. H. Duggan, president Dominion Bridge Co., Ltd., Montreal; W. Angus, vice-president of the same company.

The companies represented by the directorate have subscribed $1,200,000 out of a total authorized capital issue of $2,000,000, and no public offering of stock will be made. The directors, as will be observed, are all connected with industrial operations in which large quantities of oxygen are used. Presumably the new company will not limit itself to the making of oxygen.

PUSHING WORK ON BIG TORONTO STEEL PLANT.

Managing Director of Baldwins, Limited, in Canada on visit to Baldwins Canadian Steel Corporation—Huge plant being built in Toronto.

A one million dollar extension is being built by Baldwin's, Limited, to the plant of the British Forgings Company on Ashbridges Bay, Toronto, which the Baldwins have acquired. The addition will accommodate three tin plate mills. The present buildings are also being refitted and equipped. It is announced that active manufacturing operations will be started just as soon as the plant can be put in readiness. Bar iron, the raw material used, is to be brought from Wales, the supply being cheaper there than in the United States. A 125-ton power wheel is now being installed and about 2,000 men will be employed at the commencement of active operations next spring.

J. C. Davies, managing director of the Baldwin Steel Corporation, and Roger Beck, chairman of the Swansea Harbor Board of Commissioners, are now in Toronto in connection with the work of getting the big plant under way. Mr. Davies in a speech at a luncheon given in his honor at the King Edward Hotel said that owing to the supply of power and the conditions of supplying, the company would not be able to manufacture at the plant right away. Until the company made its plant self-contained and manufactured its own steel they would be under an obligation to the United States for the supply of steel.

Mr. Davies estimated that Canada's requirements a year at present in tin plate, galvanized sheet and like commodities ran to 200,000 tons Toronto was an ideal centre for distribution and he believed that before long that city would be an ocean port. "So long as the labor is sane I have no fear of it," he said. "I have 13,000 to 14,000 men to look after in our home factory and we had not one single strike during the whole of the war period."

Mr. J. C. Davies and Mr. Roger Beck, of Baldwins, Ltd.

The president of Baldwins Canadian Steel Corporation, as the new organization is to be known, is to be Mr. A. M. Russell of Hugh Russel and Sons, Montreal, the Canadian representatives of Baldwin's, Limited, of Swansea, Wales. The British Forgings plant, when taken over, had a capacity of 60,000 tons of steel output per year. It was built during the war by the Imperial Munitions Board, mainly for the purpose of taking advantage of the excessive steel turnings and the form of scrap that was being placed on the market as a result of the great industry in shell manufacture. Ten Heroult electric furnaces of 2,000 h.p. each were installed for the purpose. The plant, when operated under full capacity, had an output of 400 tons of steel per day and 200,000 forgings per month. With the signing of the armistice the Imperial Munitions Board placed the plant on the market and negotiations were subsequently opened between Mr. Russel, representing the Swansea steel magnates, and Toronto officials. Mr. Russell went to Wales and succeeded in interesting his English principals in the proposition with the result that what will prove one of the biggest steel plants in Canada was secured for Toronto.

DOMINION STEEL CORPORATION

English Experts Reported to Recommend "Scrapping" of Steel Plant!

London, Dec. 9.—The expenditure of from ten to fifteen million dollars on improvement of the Dominion Steel plant is planned as part of the proposed reorganization of the company by the introduction of British capital, according to a statement by Col. Grant Morden today.

Details of the new scheme, afforded by Morden, show that it is very comprehensive, involving the coordination of activities of the Canada Steamship Lines, the Century Coal Co. and Dominion Iron and Steel, in shipbuilding, and operation on a large scale. Although there is a strong Vickers interest in the British syndicate, which is taking $35,000,000 worth of stock in the steel company, Morden said no amalgamation with the Canadian Vickers was proposed.

He said British engineers after a complete survey of the company's plant, had reported in favor of scrapping nearly all of it, as it was very out-of-date and the installation of a new plant at a cost of between two and three million pounds. When this has been done Morden thinks large possibilities in the way of export as well as home trade are before the company. For years to come, it was expected, there would be a shortage of steel and of ships. The steel company would make steel and if the Canadian Government would assist shipbuilding with a subsidy, the company would build ships. The Canada Steamship Lines would thus be supplied with new tonnage needed for the projected extension of their services to British, French, Belgian, Dutch and probably American and Grecian ports. Every such vessel would be under Canadian registry and thus help form the nucleus of a Canadian Mercantile Marine, which would be entirely free from the hampering influence of control exercised by the British Ministry of Shipping.

Asked whether a holding company would be formed to co-ordinate the activities of the different companies concerned, Morden said there was a possibility of this and denied there was any deal on at present for the inclusion of the Nova Scotia Steel and Coal Company in the new scheme.—Montreal "Gazette."

SHIPBUILDING NOTES

Pacific Coast.

Total figures of ships built and launched in British Columbia during the first seven months of 1919 show an interesting comparison with those of the past two years. In 1917 twelve wooden schooners, one wooden steamer, and one steel steamer, totaling 37,300 tons, were launched, the value approximating $7,400,000.

During 1918 twenty-six wooden steamers, four schooners and ten steel steamers, having a total tonnage of 145,000 and a value of $25,000,000, were placed in the water.

During the first seven months of 1919 thirty-three wooden steamers, five schooners, and seven steel steamers with a combined tonnage of 12●,000 and a value approximating $24,000,000, were launched.

The last named period shows probably the high water mark of the industry under present conditions. The program of the Imperial Munitions Board, comprising 27 wooden steamers, has been completed, as also has the construction of the 1,500 ton wooden steamers for the French government; but twelve of the larger 3,500 ton wooden steamers for the French government are still under construction or to be built. Of steel steamers, seven are either building or about to be laid down for the Canadian government.

The tonnage of vessels still under construction or on order is 102,000, of a total value approximating $17,800,000. The majority of this program will be completed within a few months. A few of the steel steamers not yet laid down will not be launched until late in 1920.

There is a probability of further orders being placed with British Columbia shipyards, both by the Dominion government and by foreign interests, but at the present time no definite announcements are forthcoming. It is, however, probable that some additional orders for steel ships will shortly be placed, as the demand for new tonnage is still insistent. As regards wooden steamers also the future is uncertain but the satisfaction expressed by the French authorities as to the high class construction of the wooden steamers built at the Victoria yards has led to a belief that further orders for this class of vessel will be forthcoming.

North Vancouver, B.C.—Contracts for two steel steamers of 8,350 deadweight tons each has been awarded to the Wallace shipyards, North Vancouver, by the Dominon government. Work will commence immediately.

The grading has been prepared on a site adjoining the British-American Paint Company's works for a marine railway which will be capable of handling vessels up to the largest tug in Victoria Harbor. The original plans called for a floating drydock and this will be constructed at the Inner Harbor site when business is slack in boat repairing. Within two weeks it is expected to have the marine railway, which will be electrically driven, in operation. Work will then be commenced on a machine ship. The proposal is to both build and repair small craft at the new plant which was a shipyard many years ago. The marine railway has been made necessary by the amount of work which has been sublet to other firms owing to lack of facilities. It is planned to gradually add to the plant equipment until the original plans are fulfilled. The shortage of launches at Victoria this year augurs well for the new enterprise, which is to turn out small craft of every kind, from life boats to tug boats.

Interviewed regarding the report that the J. Coughlan & Sons' firm was interested in the matter of building ships for two new companies, the Vancouver Shipbuilding Company and the Western Canada Steamships Company, Mr. J. Coughlan, sr., declined to discuss the matter in detail, but stated that the firm had not sufficient contracts to assure continuity of operations for any great length of time and was arranging to build some vessels privately so as to avoid the necessity of laying off men during the winter months.

Mr. Coughlan expressed confidence that steel shipbuilding would be a permanent industry in British Columbia although there was admittedly some difficulty in obtaining immediate orders. No advice had yet been received from J. J. Coughlan, who is at present in the East, as to how many more vessels would be ordered from the firm by the Canadian Government, but Mr. Couglan, sr., feels that the government could not continue to place orders much longer and that private enterprise must now step into the breach. His firm, he said, would naturally do everything within its power to ensure the endurance of the industry it had created and the formation of private companies to build ships as an essential step to that end.

Great Lakes and Maritime.

Levis, Que.—The newly formed National Shipbuilding Co. has taken over the old-time Veilleux shipyards here and will build at least fifteen large vessels for which contracts have been secured.

The Canadian Pacific Railway's North Atlantic fleet is expected shortly to include 14 vessels with a gross tonnage of 165,000 tons. Eleven of these vessels are now in the service, and three others, the Empress of Britain, Victorian and Virginian, are being refitted after war service.

It is announced in Glasgow that the Donaldson Line had ordered six new steamers for the Atlantic trade, and that the Anchor-Donaldson Line were to build two new vessels for their Glasgow and Montreal route. Seven of the liners will be constructed in Clyde yards, while the remaining vessels will be built at Barrow-in-Furness.

During the war the Donaldson fleet suffered heavily from enemy action, the passenger steamers Athenia and Letitia being lost at sea and four cargo vessels also being sunk. To make good these losses and in anticipation of the expansion of trade the joint firms have ordered the new liners.

With the release of ships from requisition to the British Government and the growing production in the yards in the United Kingdom, various steamship companies are planning many new Canadian services.

George J. Hearn, manager of the Canadian Mission in London, recently went to Paris to interview Rumanian representatives there in connection with the establishment of a permanent steamship service between Canada and that country. As a result it is announced that four vessels will probably be put on the route, and it is understood two of them have already been secured. So great a volume of commercial business

has grown out of the Canadian contract for the supply of goods to Rumania under a government credit of $25,000,000 that a permanent service will be necessary. The contract itself is now almost completed.

The Pacific Steam Navigation Co. is making inquiries as to business offering from Eastern Canada to Chili. A number of their boats are now in the service of the British Government, and when released their idea is to have monthly sailings from Halifax, provided sufficient business is in sight. At the present time this line operates a regular service from New York to Chili.

Elder Dempster & Co., Ltd., have decided to take over the Philadelphian, now completing at the Belfast yard of Messrs. Harland & Wolff, Ltd., for their Canadian and South African service. The vessel will be known as the New Mexico. This company will have delivery within the next three months of three other vessels now in hand. Several other vessels of the same type ("N," standard) are on the stocks.

The St. John, New Brunswick, Board of Trade announces that during the coming season a Franco-Canadian line to St. Nazaire and the Houston Line to Buenos Ayres and Montevideo will operate from that port.

St. John, as an ocean port of export, has made rapid progress during the past five years, its export figures having during that period reached a total of $700,000,000. It is now the second port of export in Canada, being excelled only by Montreal. The steamship services connected with the port in the winter months are as follows: Canadian Pacific Ocean Services, which includes the Allan Line; these boats run to Liverpool and London; Furness-Withy Line—London and Havre; Head Line—Belfast, Dublin, and Avonmouth; Manchester Line—Manchester; Royal Mail Steam Packet Service—Bermuda, St. Kitts, Antigua, Montserrat, Dominica, St. Lucia, Barbadoes, St. Vincent, Grenada, Trinidad, Demarara; Anchor-Donaldson Line—Glasgow; South Africa and New Zealand Line —Capetown, Duran, Algoa Bay, Lorenzo Marquez, Delagoa Bay, South Africa; Melbourne and Sydney, Australia, Lyttleton, Auckland and Dunedin, New Zealand.

STEEL RAILS.

She sailed out o' Sunderland with a cargo o' rails—
She sailed out o' Sunderland all among the March gales;
With a cargo o' steel rails toward the Baltic she bore,
An' she'll sail out o' Sunderland with steel rails no more!

An' no one 'll tell us, for no one'll know,
If she went at last sudden, or if she went slow,
But for all that we don't know, oh, this much is sure,
She'll sail out o' Sunderland with steel rails no more.

An' the ships out o' Sunderland, they will put forth again
Bearing up for the Baltic in the wind an' the rain,
In the wind an' the weather when the March gales do roar -
But she'll sail out o' Sunderland with steel rails no more.

An' one lot o' steel rails, oh, it's just like another,
But there's no lad the same as her own to his mother—
No lad in the world like the one that she bore—
An' he'll sail out o' Sunderland with steel rails no more!

—C. Fox Smith.

CANADIAN SPINNER LAUNCHED BY CANADIAN VICKERS AT MAISONNEUVE—SEVENTH LAUCHING AT THIS YARD.

The launching of the Canadian Spinner, a cargo vessel of 8,350 tons, at the yards of the Canadian Vickers on Saturday afternoon, afforded an opporunity to Sir Montague Allan, vice-president of the company, to pass in review the achievements of that plant in contributing to the shipbuilding industry of the country. There was a large attendance of guests at the ceremany, and in welcoming them at the subsequent reception held in the board room and also in thanking Mrs. Alex. Johnston for releasing the ship, Sir Montague Allan traced the history of the company. The Canadian Vickers had been formed by Mr. F. Orr Lewis, who had originated the whole plan and succeeded in getting the Vickers firm in England to lend their name, although the Montreal firm was purely a Canadian one. The old country firm had originally been capitalized at £165,000 and today it stood at twenty-eight million pounds. During the war the Canadian Vickers had built many classes of vessels, including twenty-four submarines and about 214 motor boats, 17 trawlers and 26 drifters for British or Allied governments. In addition they had produced over a half-million shells, all of which showed what the company had done in so short a time.

"The number of the vessel launched today," said Sir Montague, "is No. 71, showing that from 1914, when we first began to build vessels here, up to the present date that number of ships had been turned out. the tonnage being about 100,000. This is a fairly good record, and I am happy to state that none of our vessels have had to be returned for any trouble with rivets or anything of that kind, and this, I think, is a great compliment to the practical men who compose our company."

Sir Montagu Allan added that there were still four more ships to be built for the Government during the winter and spring, as well as two or three others which would keep them going into next autumn. He wished to emphasize the fact that the shipbuilding industry in Canada owed deep gratitude to the Hon. C. C. Ballantyne, Minister of Marine, for the policy he had advocated and adopted. He noticed a statement in the press to the effect that the Government program included fifty-three ships, of which a good many had already been delivered, and also that those already commissioned were expected to pay for themselves—"a decided departure from the Government ownership as we understand it," he added amid laughter.

The Deputy Minister of Marine, Mr. Alexander Johnston, said that a Canadian shipowner who had bought two British-made ships had inspected the Maisonneuve plant and had declared that the ships made here were not only equal to but superior in point of equipment and workmanship to ships purchased in the yards of Great Britain. The speaker urged that Canadians must not rest content with ship-building of the present size but must aim at bigger types and turn out 12,000 instead of 8,350-ton vessels. It was personal enthusiasm on the part of the Minister of Marine that had been the chief factor in pushing to a successful issue the building of the Canadian Government Merchant Marine fleet.

The "Canadian Spinner" is a vessel of 8,350 tons d. wt., 400 feet in length, 52 ft. in breadth, and 31 ft. moulded depth.

FROM THE GREAT LAKES TO THE SEA.

Report called for on possibility of widening the St. Lawrence between Montreal and Kingston— Vast possibilities of traffic development.

Mr. W. J. Stewart, Chief Hydrographer for the Dominion, has been appointed by the Government to confer with Colonel Charles Kellar of the United States War Department with a view to the preparation of a report on the feasibility, cost, etc., of certain improvements to the navigation of the St. Lawrence River for the International Joint Commission.

Toronto as a Great Seaport.

So runs a brief dispatch recently to hand from Ottawa, and like most official dispatches it entirely misses the big point of the story. The real romance of the development of the St. Lawrence was well stated recently by Mr. Franklin K. Lane, Secretary of the Interior in the United States Government, and incidentally a Canadian by birth. He declared that if and when the St. Lawrence River between Montreal and Lake Ontario was made navigable, and subject also to the completion of the Welland and Soo Canal widening schemes, the Great Lakes would become an American Mediterranean; using the term American, of course, in the broader sense; that Toronto and other cities along the water front would become magnificent sea ports; and, finally, that Canada and the United States would save 16,000,000 tons of coal annually.

Nor, indeed, is this all. Mr. Lane said that the Great Lakes would become an American Mediterranean for at least eight months of the year, but here another story can be linked to his. There is a scheme under consideration at Ottawa right now to dam the Straits of Belle Isle between Newfoundland and Labrador, and thus divert the cold currents out into the Atlantic. It is claimed that in this way the St. Lawrence would no longer be closed by ice for a third of every year. If this plan can be carried through successfully, it adds just fifty per cent to Mr. Lane's already wonderful vision of the future.

It is stated that the first project would save the Canadian and American Governments 16,000,000 tons of coal a year. Under favorable conditions of power load factor, and of river regulation by lake storage, it would appear that full utilization would give to each of the two countries 420,000,000 kilowatt hours a month in addition to the 30,000,000 already developed on the St. Lawrence. Translated into terms of fuel conservation, this would mean as stated 8,000,000 tons of coal a year saved to each of the two countries.

For the purpose of this page, however, the main factor is the effect the scheme might have upon the development of Canada's Great Lakes port. These, of course, are the ports of Ontario and the huge volume of business they handle may be guessed by the fact that in the last year on record there passed through them nearly $1,000,000,000 worth of goods, about evenly divided between exports and imports.

Vast Export Trade.

Vast quantities of wheat come down from Ontario's grain shipping ports at Fort William and Port Arthur, at the head of the Great Lakes, and from all the thousand and one busy manufacturing towns in the middle parts of the Province there is sent out an immense quantity of manufactured goods; agricultural implements and machinery, iron and steel goods, rail way equipment, domestic utilities, factory supplies, rubber and textile and wooden manufactures; and a host of other things.

Hitherto Ontario has always been faced by this difficulty: that with all her indomitable industry she has had no proper outlet for getting her exportable surplus out of the country. She could rail it to Montreal or one of the Atlantic ports, or she could ship it via Niagara to New York or Boston. The first of these alternatives, which was the one mostly adopted, placed an additional expense on the selling price of her products, representing the difference between rail and sea carriage. The second was repugnant for patriotic reasons.

There is a third route, obviously destined by nature as Ontario's way to the sea and that is the St. Lawrence River which forms a link one thousand miles in length between the Great Lakes and the Atlantic. between Ontario and her customers overseas. Unfortunately nature left a "joker" in the Great Lakes. She gave to Canada and the United States, jointly, the biggest expanse of fresh water in the world, with magnificent potentialities for transportation and fisheries and other things; but at the same time she connected this magnificent series of inland waterways by rivers so shallow and narrow that they could only be traversed by small craft.

Giant Grain Freighters.

And in the meantime Ontario's export business was growing by leaps and bounds. She began to ship her grain in larger and ever larger vessels, culminating in the giant grain freighter, "The Grant Morden," which has a capacity of 600,000 bushels. It belongs to the Canada Steamship Lines and incidentally was built in Ontario by the well-known Port Arthur Shipbuilding Company, whose record of having produced the largest ship ever built in this country still stands.

Long before the building of the "Grant Morden" there had, of course, been attempts to clear the course for shipping to go right through from the head of the Great Lakes, a thousand miles one side of Montreal, to the Atlantic, a thousand miles on the other side; truly a magnificent project. To-day, the way is clear for the largest freighters from the head of the lakes to the Eastern end of Lake Erie, and at this point the Welland Canal is being widened to clear the way into Lake Ontario. There will then only remain the St. Lawrence between Kingston, at the eastern end of the Great Lakes, and Montreal.

It would be a costly project (possibly $65,000,000) to enlarge that stretch of river so as to accommodate big sea-going ships, but that is not the point. Like the Manchester Ship canal in England, which literally made the port of Manchester, now ranking fifth in the United Kingdom, the cutting of a big through sea channel from the Great Lakes to the Atlantic would "make" the ports of Ontario. Such a channel, no matter what it cost, would pay its interest charges and ultimately liquidate its capital cost by the sheer prosperity which it would inevitably develop in the Great Lake ports.—Ship Building and Harbor Construction.

BELCHER ISLANDS CONTAIN GOOD SHOWING OF IRON AND OTHER ORES.

(*From Our Toronto Correspondent.*)

That the Belcher Islands, up in Hudson Bay, contain extensive deposits of iron ore and that the whole James Bay and Hudson Bay region possesses climatic and other conditions that should dispel the conception of many that the district is within the Arctic Circle, is the conviction of James McEvoy, a mining engineer, who has just returned to Toronto after looking over the ground for the Belcher's Islands Iron Mines, Limited. The Islands are situated 340 miles north of Moose Factory and 500 miles a little south of east from For Nelson, or 50 miles off the east coast of Hudson Bay, above Cape Jones and it takes ten days by the present method of communication to travel by canoe and motor boat from Cochrane to the Islands. Mr. McEvoy reached Moose Factory September 10th, and at that time they were cutting barley and growing splendid vegetables. He had expected to find cold, wintry weather, but there had not even been a frost up to October 1st, when he left the district and blue-berries and cranberries were plentiful.

Mr. McEvoy is a strong advocate of the improvement of communication between the southern section at Cochrane and the shore of James Bay, and says that the linking up of the districts by a railway would open up a vast area of agricultural and mineral lands. He has a vision of the James Bay and Hudson Bay areas being a very important point on the communication line between the east and west which would become a great strategic central distribution point and a great asset to the province. The eastern side of Hudson Bay, he says, has not been prospected to any extent, but there are to be found there large areas of intrusive rock which is mineral-bearing, as well as pre-Cambrian rocks. In these rocks not only iron but some of the more precious metals may be expected to be found. Iron and copper are said to have been discovered in the district. There is great need, however, says Mr. McEvoy, aside from railway connection, of geological work outlining the mineral bearing ones and a hydrographic survey of the east coast.

In regard to the navigability of the waters of James and Hudson Bay, Mr. McEvoy says that apart from a shallow portion near the west shore, the whole expanse of water is navigable for vessels of all drafts, even to ocean going craft, and that the only thing essential to the development of ocean-going trade is the construction of harbors. Under the present lack of rail communication from Cochrane up, James Bay is inaccessible except by canoe travel with many portages, although James Bay is open till New Year's Day and the rivers leading to it freeze up early in November. Should the T. & N. O. extend its line to James Bay it would open up some valuable areas of excellent spruce timber. The fishing resources of the region, also, are extensive and with proper railway facilities fish could be delivered in Toronto from James Bay in twenty-four hours.

Hematite Ore Outcrop on Belcher Island.

Mr. McEvoy's report to his company is not yet available, but it is understood to express a favorable opinion on the possibilities of the iron-ore deposits of the region. The Belcher Islands cover a considerable area and are fifty miles from the nearest mainland. They are occupied by forty families of Esquimaux who live by fishing and hunting, red and white foxes and polar bears being their chief game.

ANCIENT BELIEFS AND PRACTICES IN RELATION TO STEEL.

Considering the state of mind and lack of knowledge of natural laws in ancient times and during the Middle Ages, it is not to be wondered at of finding superstitious beliefs of all kinds—and traces of them have lingered into modern times. I know the time, some forty-five years ago, when an English firm started a branch of their English works in the United States with English workingmen who refused to harden the tools (which they had manufactured) in American water, insisting that the water for hardening purposes must be imported from England which was done for a while. At that time I worked in a machine and engine shop in a Pennsylvania city where tons of carpenter tools, hatches, adzes, etc., were cast of malleable iron, then shipped to some place in New York where they were hardened and ground and sold as American tool steel—while the tools made of American steel were sold as English imported tools. Fifty years ago many people did not believe good tools could be made in this country. Of course not when they were made of malleable iron. The most cruel hardening process was practiced when hardening Damascene swords intended for some Asiatic potentate.

A strong, healthy slave was selected and tied down upon a suitable bench; then the heated sword to be hardened was run through the live slave in the belief that the warm blood of a human being was the best and most reliable hardening medium fit for kings and emperors only.

"Wootz" steel was used in making these Damascene swords. This steel was made in small crucibles, a couple of pounds at a time at each melt. Wrought iron was cut into small pieces and a given quantity of leaves of a given plant were put into the crucible with the iron and a cover luted on. The blast was produced by skin bellows operated by compressing one bellow with one foot while opening a second bellow with the hand, thus alternating the pressure. In European countries a good, reliable sword was so highly valued in the early Middle Ages that its possessor had it carried into the church and had the sword baptized and christened by the priest with the name of a saint, the same as children are christened today. Hence the ingenuity exerted to use the best hardening medium in conformity with the lack of knowledge of the nature of iron and steel. The principle of cementation was, however, understood and practiced by putting the iron into iron boxes, covering it with charcoal and heating the box for a long time.

Because of the erroneous idea that the degree of hardness of a tool or sword depended upon the absorption of the steel of the organic contents of the hardening medium, every smith had his own secret for preparing an effective hardening fluid, hence the great variety and exaggerated notions of preparing such fluids.

In 1555 Cosmos De Medici prepared a hardening fluid, composed of the sap of plants and claimed to be so effective that the sculptor, Francisco Taddo, could chisel a marble fountain and three statues with one chisel hardened with that fluid. Another fluid was made from mixing honey, alum, borax, the urin of a goat, salt and olive oil. This was used for softening steel.

In order to make steel so hard that it would cut iron, the following hardening fluid was recommended: The distilled juice of turnips and of the roots of cucumber.

Boiling the iron in water which contains the bark of Punic apple trees will turn it into steel.

To soften steel: Catch human blood in a dish, let the thick part of the blood settle, pour off the thin, bloody water and with a brush apply it on the heated steel. The steel will absorb the contents of the blood water and soften it.

Here again, as in the hardening of the Damascene swords by running them through a live human body, crops out the belief of the absorptive qualities of the steel and the value of the contents of the human blood as a hardening or softening medium.

The fact, already known to the ancients, that the surface of iron could be hardened by heating it in charcoal, undoubtedly led to the belief of the steel becoming hard, or soft, by absorbing substances out of the hardening fluid. Hence the eagerness to find the most effective substance.

Who is ready to blame them when even in modern days physicians proclaimed the cell theory as the source of disease until the microscope revealed the existence and presence of bacteria as the true source of sickness and infection. Yours truly,

PAUL KREUZPOINTNER.

In Proceedings of Steel Treating Research Society.

A STEEL PROJECT FOR BRITISH COLUMBIA.

It is reported from Vancouver that Thomas Summerson & Sons of Darlington, England, are considering the establishment of a steel plant on Vancouver Island, a project which was carefully considered and worked out seven or eight years ago. Mr. Percy Scott Leggatt, a director of Messrs. Summerson & Sons is now in Vancouver, and he is reported to have said that investigations of the iron ore of Texada Island have yielded excellent results.

It is also rumoured, in connection with the reorganization of the finances of the Canadian Collieries (Dunsmuir) Limited, that if the property is formally taken over by the bondholders, a steel plant is likely to be erected at Union Bay, which is now a shipping port of the Canadian Collieries. No confirmation of this rumor is obtainable.

There is every reason to believe, however, that the establishment of a blast furnace and open hearth plant of the orthodox type is likely to take place on Vancouver Island in the near future.

METAL QUOTATIONS.

Fair prices for ingot metals in Montreal as at December 8th, 1919:

	Per Lb.
Electro copper	24
Casting Copper	23½
Lead	8¼
Tin	59
Zinc	10½
Antimony	11
Aluminum	33
Steel Bars	$3.10
Plate	3.35

THE FUTURE OF BENZOL.

Mr. D. R. Wattleworth (Gas World) describes some of the troubles of benzol as a motor fuel and their remedy. Complaints usually take one of the following forms:—(1) The valves and valve stems of the engine became coated with a gummy substance, with the result that in time they stuck in the guides; (2) the valve faces became deeply pitted and corroded; (3) in cold weather the benzol froze, usually in the carburetor jet, which, of course, resulted in the pulling up of the engine; (4) the benzol contained water, which collected into drops, found its way into the carburetor, and prevented the free flow of fuel to the jet.

The causes of these troubles are now well known to benzol producers. The gummy deposit on the valve stems is caused by insufficient washing of the benzol with sulphuric acid. There are certain impurities in the crude benzol which, although quite liquid under ordinary conditions, are capable of being polymerized into resinous compounds. Strong sulphuric acid possesses the property of bringing about this change, and it is for this reason among others that the crude benzol is washed with R.O.V. Insufficient washing leaves some of these compounds in the benzol unchanged, with the result that the heat and pressure of the motor cylinder complete the change, and the polymerized resins are formed there instead of in the benzol washer. These resins find their way down the valve stems, and in time we get a "suck-up" valve. Experience has shown that in washing bezol the best results can be obtained only by using the strongest acid. Pitting of the valve seat results when using benzol which contains an excessive amount of sulpuhr.

All commercial benzol contains sulphur, chiefly as thiophene and carbon disulphide. Thiophene is removed to a large extent during the washing with sulphuric acid. On account of the low boiling point of the carbon disulphide, the forerunnings always contain a large proportion of this impurity, and by discarding this fraction the amount of sulphur in the total distillate can be considerably reduced. To obtain the best results the still should be started up very slowly, and the flow of distillate kept very small until the greater portion of the carbon disulphide is fractionated off. A trouble frequently arising from the use of a benzol containing an excess of sulphur is the thickening of the lubricating oil, but only when vegetable oils are used. The sulphur in the benzol is oxidized during the explosion to sulphuric acid, and this reacts with the vegetable oils and thickens them. The trouble can be overcome by using mineral lubricating oils, but the real remedy is the elimination of the sulphur from the fuel.

Freezing of the benzol in cold weather is entirely due to its being too high in benzene, but the addition of from 15 to 20 per cent of toluol will reduce the freezing point of the benzol well below the temperatures usually met with in this country.

Water is usually found in benzol which has not been sufficiently matured; and for this reason the benzol should be allowed to stand in the storage tanks some days before being transferred to drums, tank wagons, etc. All storage tanks should be fitted with drain cocks at their lowest point, so that any water accumulated may be run off. When loading drums and tins, all benzol should be run through a fine-mesh gauze.

ELECTRIC WELDING IN THE IRON AND STEEL INDUSTRY.

Some interesting information bearing on the usefulness of electric welding in the iron industry was given in a paper read before the American Institute of Electrical Engineers, by F. K. Dalton of the Hydro-Electric Power Commission at the Engineers' Club in Toronto on November 21st. When the German ships interned in American ports were taken over by the United States it was found that enormous damage had been done to the propelling machinery, particularly to the engines. Cast-iron portions of the equipment suffered severely, so much so that the Germans in listing the damage done, made notes to the effect that the damage done could never be repaired. A period of at least a year and a half was estimated as the least time in which repairs could be effected, but by the use of the arc-welder this time was cut down to about five months. The various types of equipment on the market today were fully described by Mr. Dalton and the welding practise in general was fully gone into. Arc-welding, both by direct and alternating current has come into considerable prominence during the past few years, and has found many applications. The arc-welded ship, without rivets, is more than a possibility, and throughout the iron and steel industry, from the steel mill to the machine shop, electric welding is used, not only to repair break-downs, but as an aid in the production of the finished product.

OBITUARY.

The death is announced of Mr. E. L. Gilpin of Sydney, N.S., following pneumonia, at the early age of forty-three years.

Mr. Gilpin was property agent of the Dominion Iron & Steel Company, and secretary of the Employees Mutual Benefit Society. Joining the Steel company's staff twenty years ago, before the plant was built, he had been in the company's service for as long a time, if not longer, than any other official or employee. As property agent of the company, he was brought much into touch with the municipal and civic officials of Sydney and district, and took much interest in the civic development of the city. As secretary of the Benefit Society he was known to all the employees of the company, and in other directions his activities were varied and extended.

Mr. Gilpin belonged to a family with a long and honorable record in Nova Scotia, his father, Dr. Edwin Gilpin, having been Commissioner of Mines for many years. His grandfather was Dean of the Cathedral of Halifax.

In factories where needles are made the grindstones throw off great quantities of minute steel particles, although the dust is too fine to be perceptible to the eye. Breathing the dust shows no immediate effect, but gradually sets up irritation, usually ending in pulmonary consumption, and formerly almost all the workmen died before the age of forty. Ineffective attempts were made to screen the air by gauze or linen guards for nose and mouth. At length the use of the magnet was suggested, and now masks of magnetized steel wire are worn by the workmen, and effectually remove the metal dust before the air is breathed.

MAGNESIUM

A question which is bound to receive consideration in all leading industrial countries after the war, is the continuation or abandonment of works put up to supply special material, which, in pre-war days, was imported from other countries, where the production of these particular products has attained an economic basis. These considerations particularly apply to the manufacture of the rarer metals, not merely our old friends the steel hardeners, like tungsten and molybdenum, but the metals whose special qualities suggest that they may form valuable raw material for engineering purposes, either in their pure form or as alloys—such metals, for instance, as magnesium and cobalt.

Magnesium, besides being one of the constituents of duralumin, was used in the production of star and tracer shells, tracer bullets, and also for the production of special explosives known as "Ofourite," which consisted simply of a mixture of magnesium powder and an oxydising agent. Prior to the war, this country's demand was small, amounting, probably, to 100 tons a year, and was derived entirely from two German works—the Griesenheim Electron Gesellschaft A. G., and another plant operating near Bremen. Up to about 30 or 40 years ago, magnesium was manufactured by Messrs. Johnston, Matthey & Co., at Patricroft, where they employed the sodium process, the metallic sodium being one of the products of their Patricroft works. However, the development of the electrolytic process in Germany, using as raw materials the chlorides of magnesium and potassium from the great Strassfurt deposits, made competition impossible —at any rate in a commodity of so small application, and the manufacture was abandoned.

On the outbreak of war, the German imports were immediately cut off, and stocks obtainable from other centres do not appear to have exceeded a few cwts. Under these circumstances, it was obvious that the manufacture must be immediately recommended in this country. At this time, Messrs. Vickers, Ltd., as the manufacturers of duralumin, took the matter of production in hand. At Patricroft, not only had the plant gone, but the men who operated it had also passed out, so that it became necessary to recommence operations altogether. Two alternatives presented themselves: either to follow the German practice of electrolysis analogous to the Castner sodium process, which is practically that worked out by Sir Humphrey Davey, of else to fall back on the old sodium process. As electrolytic processes are notoriously slow to perfect, and the price was not material, the sodium process was naturally selected, and within three months magnesium was actually being turned out at the works at Greenwich by the Magnesium Metal Co., Ltd., which company had been formed by Messrs. Johnson, Matthey & Co. and Messrs. Vickers expressly for this purpose. The Magnesium Metal Co., produced the bulk of the supply available during the war, although we understand that small quantities were imported from Canada, where the manufacture had been instituted as a war measure.

Concurrently with the production of magnesium by the old process, the Magnesium Metal Co. proceeded to try out electrolytic manufacture, and the position to-day is that they have a unit of a capacity of 100 tons per annum about to begin operations.

As regards raw material, there are, of course, large supplies available from Greece, but a successful process has been worked out which would enable the deposits of dolomite, the double carbonate of magnesium and calcium, in the Peak District, to be utilized in case of foreign supplies being cut off, though, naturally, at a somewhat higher cost. There are also large supplies of magnesia mineral in Canada (ct. M. J., May 17, 1919, p. 299), South Africa, and Australia, so that the industry is satisfactorily situated in relation to raw material.

At the present moment material is in short supply, commanding 22s. 6d. to 30s. per lb., as compared with, say, 5s. before the war, and unless supplies are available from Germany, for which very low offers are reported to have been made, there can be little material available until the Magnesium Metal Co.'s new works are producing. As soon as that moment arrives, however, it is obvious that the price must fall very considerably; in fact, it is anticipated that the metal will be sold ere long at something like the pre-war price.

An important question, however, still remains to be considered. Is magnesium to remain a rare metal, or will the policy be to develop it on a commercial scale, as has been done in the case of aluminum? This is a question to which it is not possible to give a positive answer at the moment, as, of course, it is necessary to develop demand hand-in-hand with production. Ideally the metal has great commercial possibilities. It has equal tensile strength to aluminium, and is 40 per cent lighter, and we have been shown pieces of metal which have been exposed to the London atmosphere for a long period without any signs of oxidation or deterioration. Consequently, it may be taken that metal of a sufficient purity has now been produced to be air stable. The importance of a metal of similar qualities to aluminium, but nearly half as light again, needs no argument, especially in these days of enormous automobile expansion, to say nothing of aircraft. It will, however, be necessary to work out alloys through a series of metallurgical researches, and then to popularize them in the engineering trades. Such propaganda inevitably requires time, and until it has been effected production on a large scale is not to be looked for. Present indications, however, are that there should be a large consumption either for pure magnesium or for alloys containing a high magnesium percentage on a big scale, eventually, perhaps, reaching that of aluminium itself, which is selling to-day at a price of, say, 1s. 5d. per lb.

PERSONAL

Norman M. Campbell, who has been associated with Canadian Ingersoll-Rand Company, Limited, for the past twenty years, has resigned his position as General Sales Manager and Director of that Company, to take effect December 31st.

Mr. Campbell has been appointed Managing Director of General Combustion Co. of Canada, Limited, Manufacturers of "Oilgas" industrial furnaces, under the well-known Sklovsky patents, with headquarters in New Birks Building, Montreal, and will assume his new duties on the first day of January.

RULES FOR OPERATING ACETYLENE WELDING AND CUTTING OUTFITS.

The following rules for operation of oxyacetylene welding and cutting have been adopted by the Western Pennsylvania Division of the National Safety Council:

Under no condition should acetylene be used where the pressure is greater than 15 lb. per square inch.

Special care should be given to the storage of oxygen and acetylene tanks. Acetylene is classed as an explosive as other hydrocarbon gases and only a limited number of containers should be stored in one place. Oxygen tanks should be stored in a separate place from acetylene tanks.

Oxygen and acetylene tanks should not be allowed to remain near stoves, salamanders, furnaces, steam heaters or other sources of heat and should not be exposed unnecessarily to the direct rays of the sun, as an increase in the temperature of the gas will cause a corresponding increase in the pressure within the tank. Any excess of heat may also soften the fusible safety disk with which the tank is provided, causing it to blow out and permit the gas to escape.

Oxygen tanks should never be handled on the same platform with oil or grease which might find their way into valves on the tanks.

Oxygen and acetylene tanks should never be dropped or handled roughly and should never be stood on end unless fastened so as to prevent them from falling over.

All empty tanks should be marked plainly with the word "empty" and returned promptly to the storeroom.

An open flame should never be used for the purpose of discovering leaks in acetylene tanks. Leaks can generally be detected by the odor of the acetylene gas, and their location can be determined by applying soapy water to the surface of the tank and watching for the soapy bubbles formed by the escaping gas.

No repairs to oxygen or acetylene tanks or equipment should be made or attempted. All defects should be reported promptly to the foreman.

Leaking acetylene tanks should not be used, but should be placed in the open air and all open lights kept away from them. All leaking acetylene tanks should be reported promptly to the foreman and immediately returned to the manufacturer.

All open flames should be kept away from any place where there is any possibility of acetylene escaping.

Care should be taken to protect the discharge valves of the tanks from being bumped, as a jar may damage the valve and cause it to leak.

Grease in contact with oxygen under pressure may cause spontaneous ignition. Great care should be taken not to handle threads or valves with oily hands or gloves, and gages should not be tested with oil or any other hazardous carbon. If a lubricant must be used, the purest glycerine is permissable.

Gages, apparatus and torches requiring repairs should be sent to the manufacturer, and local repairs should not be attempted. Valve seats should never be replaced except by the manufacturer.

The use of operation of the pressure regulator or reducing valve on oxygen or acetylene tanks should be as follows: (a) Open the discharge valve on the tank slightly for a moment and then close it. This is to blow out the valve any dust or dirt that otherwise might enter the regulator. (b) By means of the stud or nut connection on the regulator, connect the regulator to the discharge opening of the tank. (c) Release the pressure adjusting screw of the regulator to its limit. (d) Open the needle valve slightly if there is one. (e) Open the discharge valve on the tank gradually to its full width. (f) Open the needle valve to its maximum if there is one. (g) Adjust the pressure regulating screw until the desired pressure is shown on the low-pressure gage.

The discharge valves on the tanks should be opened slowly and care should be taken to avoid straining or damaging them by the use of a hammer or improper wrench. A special whench should be made for use in opening these valves in case they stick.

When the operation of the cutting or welding torch is applied for a short time the needle valve on the regulator should be closed, or the pressure-adjusting screw should be released to keep the pressure off the hose. The torches should be opened momentarily to let the pressure out of the hose lines.

Proper precautions should be taken to protect the hose from flying sparks.

All hose should be examined periodically at least once every week. This should be done by cutting the hose off at the end of the connection and examining it. In addition, after a few months'use, the hose should be cut off about two inches back of the connection and examined for defects. A defective hose should never be used.

Special care should be taken to avoid the interchange of oxygen and acetylene hose or piping, as this might result in a mixture of these gases that would be highly explosive. The practice of using right and left-hand threads is recommended.

White lead, grease or other similar substances should never be used for making tight joints. All joints and leaks in equipment should be made tight by soldering or brasing.

The oxygen and acetylene valves at the base of the torch should be tested daily for leaks.

Where hydrogen or other gas is used instead of acetylene, the same precautions should be observed as for acetylene.

Men using welding apparatus should wear suitable welding goggles for eye protection, having frames that are non-conductors of heat (not celluloid), side shields to protect against hot particles of metal, and lenses of proper color.

If valves become frozen they should be thawed by hot water, not by flame or hot metal rod.

Portable generators should not be used inside of the building.

Safety devises on tanks, generators or apparatus should not be removed or tampered with.

In welding brass or bronze, injurious fumes may be given off, making it desirable to wear a respirator.

Smoking while on duty should positively be prohibited.

The manufacturers should provide couplings for the hose which cannot be mistaken and put on the wrong hose. If the couplings could be made with proper connections, it would be impossible to make any mistake.

In storage houses where hydrogen or acetylene tanks are stored, the wiring should conform to the same rules as for the generator house so that it would be impossible to cause an explosion from defective wiring or a break in the bulb.

The valves on the piping should contain neither copper, brass nor bronze.

In opening the outlet valve of a full tank, do not remove the regulator.

The operator should not stand in front of the gages when opening the discharge valves on the tank. If the pressure goes off suddenly, it may possibly destroy the gage, and if it does, the glass and parts will be blown out at the front.

COST OF SHIPBUILDING IN AUSTRALIA.

Three steel vessels have recently been added to the Australian Government merchant fleet, viz., the Delungra, Dromana, and the Bilocla. A recent official statement was made to the effect that the cost of the vessels, including interests, depreciation and working charges, would not exceed the original rough estimate of £28 per ton, and that the cost of a similar vessel abroad would be in the neighborhood of £38 to £40 per ton at present. The wages paid in connection with the Dromana were £3,900 more than what would have been paid in Great Britain, and the engines, it was stated, had cost £5,000 more; also that lower costs for labor and material were necessary to make the shipbuilding in Australia commercially successful.

About four months ago, owing to the "go slow" methods of the riveters engaged at the Cockatoo Island dockyard, Sydney, in the construction of the Bilocla, summary notice of dismissal was served on the men, and they were only permitted to resume work on piece work conditions.

These conditions resulted as follows: Platers averaged £1 15s 9d per day; riveters by hand, £1 9s 1d; riveters using pneumatic hammers, £1 2s 7d; platers' helpers, £1 7s 3d; pneumatic drillers, £1 1s 6d, and caulkers 16s 5d. Compared with the old award rate of 12s per day, the results showed an increase in earnings as follows: Platers, 196 per cent; riveters (hand), 114 per cent; riveters (pneumatic hammer), 88 per cent; platers' helpers 159 per cent; pneumatic drillers, 62 per cent; and caulkers, 37 per cent. Where the platers were earning the minimum of £3 12s per week, they are now averaging £10 14s 6d per week.

During the war period a number of contracts were let to private firms for the construction of small composits vessels of about 1,500 tons in the various ports of the commonwealth. All these contracts have now been cancelled, and the question remains to be decided what is to be done with such portion of the hulls that have been constructed. None of these have got past the stage of setting up the frames. Several of the firms whose contracts have been cancelled have announced their intention of completing the vessels.

The Federal Government have decided on the continuance of the shipbuilding scheme as regards the steel cargo carriers. It has been announced that several vessels of 10,000 tons will be constructed, and that Sydney will be the port so favored. Owing to its proximity to the Broken Hill Proprietary Company's works and the chief coal supplies of Australia and other natural advantages, Sydney is undoubtedly the most suitable port for shipbuilding purposes.

Taking into consideration the fact that not more than 10 per cent of the men employed had had any previous experience in connection with shipbuilding, it is stated that the authorities do not view with alarm the increased cost of labor, and they anticipate that, with more experience the cost will be considerably reduced.

The Commonwealth Government recently announced its firm intention to continue its shipping operations regardless of whatever opposition might be placed against it, also that it had no intention of disposing of the present fleet, which was originally established for the purpose of providing freight facilities during the currency of the war. Strong opinions were then expressed regarding the government's action in purchasing small and somewhat antiquated vessels at what seemed to be an exorbitant sum, but subsequent events proved the wisdom of the course adopted, and many a ton of freight was lifted between foreign and other ports and Australia at extremely profitable rates.

At present forty steamers are being operated by the Commonwealth Government, and it has also been directing the course of nineteen ex-enemy steamers almost since the commencement of the war.

STAINLESS STEEL.

The literature relating to this interesting alloy is exceedingly meager. Two contributions have been made recently, however, which throw some light upon the history and properties of this alloy, although the chemical composition is not disclosed. Stainless steel was discovered in the research laboratories of Thos. Firth & Sons, Ltd., Sheffield, by Harry Brearley, while working on armor piercing projectiles for the Russian Government. It was soon found that the new alloy did not scale easily and did not tarnish when exposed to the action of many acids, including fruit acids. This suggested its use in the cutlery trade. R. F. Mosley's cutlery works was the first to use it for this purpose. The alloy is not protected by patents in England, but the foreign patents are controlled by the Firth-Brearley Stainless Steel Syndicate, with the exception of the American patents, which were sold to a co-operating body of large steel makers, the American Stainless Steel Co., of Pittsburgh. (U. S. P. 1,299,404, granted to Elwood Haynes on April 1, 1919, and assigned to this company, relates to a chromium-iron alloy containing 20 to 25 per cent Cr and 0.1 to 0.5 per cent C., which is claimed to be practically permanent against fruit acids, exposure to air and rain, etc.).

This steel is capable of attaining, by suitable heat treatment, a wide variation in mechanical properties up to extreme hardness. It does not scale appreciably under 800 deg. C., while its tensile strength is not materially reduced at 400 deg. C. This property, in combination with the resistance to erosion, led to the use of the alloy for the manufacture of exhaust valves for airplane engines. Among other engineering applications of the alloy may be mentioned: Turbine blades, pump rods and valves, acid pumps, rams, cotters, evaporating pans, races and rollers for bearings, steam traps, etc. Since the steel is unaffected by salt water or sea air, it may be employed for a variety of marine purposes. In the electrical field, stainless steel is used for permanent magnets and for electric cooking stoves and utensils, where the advantages of permanently bright and clean surfaces in assisting the reflection of heat and consequent economy of current are immediately apparent.

LABOR CONDITIONS IN AUSTRALIA.

The Editor, *Mining & Scientific Press*, San Francisco:

Sir—Having recently spent some time in Australia and New Zealand while **en route** from India to California. I thought that perhaps a short account of the labor conditions now prevailing at the Antipodes might interest you. I should explain that owing to the number of people waiting at Hong Kong and Shanghai to cross the Pacific I was unable to get a passage to America by that route, so I decided to proceed to Australia and take my chance of a passage from there. At the same time I knew that I was liable to be held up there by strikes and in this I was not disappointed. It took me four months to reach America from India. It happened to be the seamen's turn to take a holiday, with the result that no steamers except a few ocean liners were plying round the coast of Australia, and between Australia and New Zealand, Tasmania, Fiji, and other Pacific islands. Many New Zealanders, including returned soldiers, were stranded in Sydney and Melbourne. In addition to this, the two steamers of the Canadian-Australasian Line, being manned by Sydney crews, were laid up on their arrival from Vancouver. The steamers of the Oceanic Steamship Co., being manned by American crews, were not affected, but they were booked up months ahead. There was scarcity of sugar, salt, etc., in Sydney and of flour and other foodstuffs in north Queensland. In these circumstances, the Queensland Government dredge was loaded with 200 tons of flour, but when she was ready to sail for northern Queensland seven of the firemen walked ashore with their kits. Mr. Hughes, the Prime Minister of Australia, was on his way back from the Peace Conference, and in his absence the Australian government seemed to be afraid to do anything toward settling the strike until it had been going on for about seven months in Queensland and four months in New South Wales and Victoria.The ships are supposed to be under the Shipping Controller, who is an Admiral. There are thousands of unemployed in Australia and surely a sufficient number of non-unionists could have been obtained who could stow cargo and fire a boiler. But Australia is so completely in the grip of the labor-unions that no one even suggested this way out of the difficulty, although it was done some years ago when the unions refused to load the transport going to Europe. Of course, the strike affected others besides the seamen and firemen, namely, ship's officers and engineers, stewards, wharf laborers, teamsters, coal miners, and smelters.

In striking, the unions were defying the law, as they were or should have been working under an award of the Arbitration Court which had not expired, and were consequently liable (in theory) to be fined. After considerable delay the Secretary of the Union, named Walsh, who is married to one of the notorious English Pankhurst family, was tried and fined \$500, which he refused to pay and would not allow the Union to pay. As he still persisted in defying the law, he was fined \$1000 more and awarded three months imprisonment, but without hard labor. In fact, after a short hunger strike à la Pankhurst he spent the time in the jail hospital where the food was better, but the strikers announced that they would not return to work until he was released. The Union and its president were also summoned, but the case against them was adjourned from week to week, and by the time the strike terminated nothing had been done. If, on the other hand, the employers had been at fault, no time would have been lost in summoning and punishing them. Such is life under a Labor government in Australia. Compulsory arbitration has had a thorough trial there and has been a complete failure. During this strike even the strikers announced that they would have nothing more to do with it, although, under Judge Higgins, the unions have almost always succeeded in getting better conditions. This time their demands included an increase of 35 shillings per month and better accommodation. As you are aware, this is not my first visit to Australia and these are not hasty impressions. I have lived there for more than ten years and in New Zealand for five years.

Owing to this strike, 25 ships belonging to the Commonwealth government were laid up in Australia at an estimated loss of \$50,000 per day. The long-suffering public, of course, will have to bear this loss. One would think that in these circumstances the Government would do its best to settle the strike. I cannot imagine the American government allowing 3000 men to hold up the trade of this country.

After the strike had been in progress for some time the union organized gangs of strikers to go up country rabbit-catching and other parties to go out deep-sea fishing to raise money to further the good cause. Every Sunday crowds gathered in the parks to listen to loud-mouthed speakers and the hat was passed round for the benefit of the suffering wives and children of the strikers. Soup-kitchens were also opened, to enable the lawbreakers to hold out longer. Incidentally I may mention that saloons in Sydney close at 8 p. m. now.

While the shipping strike was raging there was a miners' strike at Broken Hill, but as this is almost a chronic condition there it did not attract much notice in Sydney. All they want is a 6-hour day, 5 days a week, \$5 per shift as a minimum wage for men and boys. At that time there was 100,000 tons of lead lying at the Port Pirie smelter, where most of the Broken Hill galena concentrate is smelted. This accumulation was caused by scarcity of shipping space. At the same time most of the copper mines in Australia were shut-down for the same reason or because the cost of production was too high to leave any profit. Scarcity and inefficiency of labor were chiefly responsible for this. Other companies complained that the Metals Exchange would not allow them to sell their copper.

The Mount Morgan mine shut-down because they could not ship blister copper to the refinery at Port Kembla on acount of the shipping strike, and it cost too much to send it by rail. The Queensland government compelled them to resume operations under threat of taking possession and working the mine itself! The Broken Hill Proprietary Co.'s iron and steel works at Newcastle, N. S. W., were shut-down because they could not get iron ore from South Australia, limestone from Tasmania, and coke from the Illawarra district of New South Wales. The electrolytic copper refinery at Port Kembla was idle because they could get no blister from Mount Morgan or Mount Lyell and the custom-smelting department was idle because no purchased ore was coming forward. This company had 12,500 tons of wire-bars and ingots worth more than £100 per ton on hand in July because it could not get permission from the Shipping Controller to ship to England, though most of it was

sold to the British government. The same condition prevailed at Port Pirie and Cockle Creek as regards lead and zinc.

At the Mount Morgan mine during the last half-year figuring on the directors' report, the cost of producing a ton of blister copper was about £143 ($610.) Fortunately for them they can produce blister carrying $400 worth of gold per ton. At Wallaroo, in South Australia, costs are $90 per ton of blister copper. At Mount Morgan there was a strike because a returned soldier was given a job in the mill, although the man he displaced was given another job. The manager told them that if they didn't return to work in two days he would close the whole works down. They returned. They are just like children.

Under the coal and coke workers' award, coke-wheelers get 14s. 7d. per day. Some mechanics at Port Kembla gave up their jobs to go coke-wheeling.

The State of Queensland made a loss of £1,500,000 on its railroads last year and one of the ministry (who are Irish laborites) said he didn't think they should be expected to pay. They also made a loss of £45,000 in 3½ years on the State coal mine and closed it down, but they now intend starting an iron and steel industry. They have also bought the mines, railways, and smelter of the Chillagoe company, which has spent millions on them in the last twenty years and never paid a dividend. They intend to spend $500,000 in opening the Einasleigh mine and putting the smelter in order. There is no chance of making a genuine profit. I have been there. They are also opening up a State arsenic mine to make a mixture to kill the prickly pear! Can you beat it!

At the Mount Elliott smelter in Queensland the furnace-men went on strike because they did not approve of the management lengthening the furnace to 28 ft.. To please them, the length was reduced to 18 feet. Could this happen anywhere else?

The shipping strike, according to the Sydney 'Sun,' caused a loss in wages of £1,363,000. How long will it take the poor fools to make up this, even if they get an increase? If they are not being paid a living wage now can they afford to be idle from four to seven months?

Some years ago the Kanakas who worked on the sugar plantations in Queensland were deported, and the 'white Australia' policy was initiated. The cane-cutting is done by contract and the laborers refuse to work unless they can make £2 or £3 per day. Consequently less cane is being planted now than formerly and sugar has to be imported from Java and Fiji.

At Broken Hill, after four unsuccessful attempts in three weeks at the South mine and two by the Zinc Corporation, certain persons succeeded in burning down the headgear, 130 ft. high, the ore-bins, and part of the mill at the Broken Hill South, which was idle on account of the strike. This was the only mine at Broken Hill that employed any hands—chiefly on repairs and to relieve distress, and was the only one picketed by strikers. The damage is estimated at £90,000 ($400,000) and will take a year to replace. The Amalgamated Miners Association naturally deny that they had anything to do with it and insinuate that it was due to the carelessness of the management. The company offered a reward of £2000 for information leading to the arrest of the guilty parties.

About half the mileage of railways in New South Wales doesn't pay, but more roads are projected—with borrowed money, of course—to keep politicians in office. The same old game. They are even borrowing money now to repair roads.

At the Pelaw main colliery, in New South Wales, miners landed in trucks 2700 tons of coal in seven hours, earning over £2 per head.

In ten years Australia paid £625,000,000 for imports.

The miners at the Victorian State coal mine went on strike because the roads were muddy.

It is reported by the Commonwealth statistician that in six years up to 1918 there was 2153 disputes involving 7697 establishments. The workers numbered 9,156,589, and the loss of wages was £5,073,346. In 1918 there were 298 disputes.

The price of potatoes was fixed by Government at £18 per ton. And this is supposed to be an agricultural country! Wharf laborers at Wellington, N. Z., refused to load potatoes on an outgoing steamer. They said the export of potatoes was making the price high in New Zealand.

Australia's national debt is now £700,000,000 and its population about five millions. The debt per head is £140. The Government tries to prevent capital from leaving the country; for example, the Austral-Malay company bought a tin mine in Bolivia, but the Government would not allow them to raise money in Australia to work it; consequently they registered a company in the United States at considerable expense, but have now removed the office to the Malay States.

It is well recognized that Australia is the working man's paradise and the educated man's purgatory. For instance, the Geelong Council advertised for an accountant at £156 per annum (10s. per day) and at the same time increased its laborers' daily wage to 10s. 8d. Many instances might be given of the same thing. In August last the Waterside Workers Federation applied to the Arbitration Court for more pay and improved conditions. The secretary said he thought it was quite right for men who started work at 10 minutes to 9 to knock off at 9 o'clock for a smoke. He also asked for treble wages for Sunday work with a minimum of four hours engagement, which, might mean in certain cases—such as handling explosives—a wage of £2 13s. for half an hour's work! In the case of the gas employees, members of the union claimed to be paid interest equal to the dividend paid to shareholders, such interest to be paid on the wages earned. Even Judge Higgins balked at granting this demand.

In testifying before the Railway Appeal Board in Queensland, after the Railway men's Union had warned its members to prevent a trainload of police from reaching Townsville during the riots, more than one unionist swore that he would have risked his life had he disobeyed the union and it was better to disobey his employers, namely, the State.

WILLIAM MOTHERWELL.

Note:—The reason for re-publishing this letter will be apparent to those who take the trouble to read it. —Ed.

EDITORIAL

The Growing Importance of Ferro-Alloys

The production of ferro-alloys in Canada has recently developed into an important domestic industry, and Canadian steel companies will note the importance of the growing control of alloy metals by important groups of United States steel interests, and particularly the out-and-out purchase of the Primos Chemical Co., its refineries and mines, by the Vanadium Steel Corporation.

Mr. Replogle's statement with reference to Prof. Arnold's new formula for molybdenum steel is the first accurate information to hand regarding the much-heralded "super-steel," the invention of which is credited to this distinguished Sheffield metallurgist. Prof. Arnold has, it is understood, substituted molybdenum for tungsten, with the addition of a larger proportion of vanadium than has been hitherto used. From the meagre information so far available, there seems no justification for the hysterical cables that have emanated from London, nor for any immediate or marked increase in the value of molybdenum properties.

At the same time, it is quite evident that the use of such materials as vanadium, molybdenum, chrome, nickel, magnesium and tungsten in varying combinations for the purpose of imparting certain specifically desirable qualities to steel, is becoming increasingly common and increasingly important, and that much of the behavior of steel under specific conditions of heat-treatment and admixture with alloy materials is now becoming more clearly understood through the advance of metallography, and the greater certainty and flexibility of pyrometric records that has been achieved. It is also fully evident that those who are in charge of large steel-making operations in the United States are wide awake to the necessity for assuring themselves of sources of supply of alloy materials. In this issue of "Iron & Steel" will be noticed a review of a description of the mineral resources of South America by Drs. Miller and Singewald, which contains, among other things, an interesting description of the Minasragra Vanadium Mine, by virtue of the ownership of which the Vanadium Corporation of America control eighty per cent of the presently available supply of vanadium. From time to time, Canadian interests have looked into the possibilities of South America as a source of iron-ore supply, but perusal of the work mentioned will show that South America is equally interesting as a potential source of alloy materials.

So far as is known today, Canada does not contain such large deposits of Bessemer ores as lie immediately south of the line, nor does Canada possess large deposits of coking-coal in reasonably close proximity to such ores, excepting the notable exception of Sydney, Nova Scotia; the ores in this case, while not in Canada, being in a neighboring British country. Therefore, it does not seem probable that Canada—out of her own unaided resources—can compete with the United States in tonnage production of iron and steel, until such time as the United States itself shall have come down to the use of non-Bessemer ores. But, on the other hand, Canada is admirably equipped for the successful operation and growth of a ferro-alloy industry, seeing that she possesses indispensable alloy materials within her own borders, together with water-powers assuring comparatively cheap provision of electric current. Canada, in many respects, resembles the Scandinavian Peninsula, and there is no reason, with proper development of her water-powers and because of her possession of a select and comparatively rare group of minerals, why Canada should not become the home of a very specialized metallurgical industry, based securely on the country's own resources and independent of outside sources of supply.

Canada's Part in the Steel Trade of the Empire

The Toronto "Saturday Night" of recent date contained a discussion, under the foregoing title, by a writer who uses the pen name of "Economist," which is reprinted in this issue. The writer argues that Great Britain can place herself in a position of vantage in the iron and steel industry comparable with that now occupied by the United States, "by making herself a part of Canada," and presumes that Canada's natural advantages approximate to those of the United States. "It is true," states "Economist," "that Canada has no anthracite coal, but she has endless quantities of bituminous coal, and of iron ore."

Later, our writer suggests that we should expand our imaginations to take in the vast expenditures that may be regarded as commonplace when Canada's steel industry really gets on its legs. "Either that," he writes, "or we are only repeating grotesquely exag- "gerated statements when we talk of the wonderful "iron and coal and mineral deposits, the vast inland "waterways, the enormous water-powers, timber re- "sources and wheat lands of Canada, and the need "of the world for the products of this country."

We would not go so far as to assert that all such talk is grotesque exaggeration, but a lot of it is unreasoned optimism. There is nothing clearer to those who have studied the whole matter than that the coal and steel industries of Canada, particularly Eastern Canada, have very distinct limitations. We have not endless quantities of bituminous coal. Compared with the United States, we are meagrely supplied with that essential basis of civilization, and our coal resources are very largely concentrated in only partially settled portions of the provinces of Alberta and British Columbia. From Sydney to Winnipeg it may be said that the only coal resources of Canada are those of Nova Scotia, and these are not illimitable—not by any means. Moreover, seventy per cent of the coal now mined in Nova Scotia is from submarine areas, and submarine extraction necessarily is accompanied by steadily increasing costs of extraction, a smaller percentage of recovery, and a very considerable amount of general uncertainty as to the future.

The present coal production of Nova Scotia is a little over five million tons per year. The largest annual output which optimistic calculators have allowed themselves to predict for the future maximum coal production in Nova Scotia is ten million tons per year, and we believe that prediction to be extremely roseate.

The coal production of Britain, even in its present depressed condition, exceeds 200,000,000 tons annually, and that of the United States approximates 800,000,000 tons with an easy potentiality of a billion tons per year. Canada's production in 1918 was 12½ millions, and, so far as the application of coal to steel manufacture is concerned, taking into account limitations by distance and unsuitability of certain coals for metallurgical uses, we do not see where a tonnage of coal in excess of five million tons could be produced from Canadian collieries in the East, for use in metallurgical works, at any reasonably predictable period of the future. And, it may be added, coal can only be produced when the operation is a profitable one, and this limitation has already caused the closing down of submarine workings.

So far as Nova Scotia is concerned, the limitation of metalllurgical expansion will arise rather from a coal insufficiency than from an insufficiency of iron-ore, because the possible production from the Wabana ore mines has not been fully tested, and its adequacy cannot be questioned.

As concerns the West, while there is a great deal of coal in Alberta, the close presence of suitable iron ores has not been reported. The possibilities of British Columbia, or more specifically, Vancouver Island, have already been fully dealt with in these columns.

Turning to iron-ore supplies, in regard to no raw material is the principle of relative values so well established. Canada has large deposits of iron-ore, but the United States has large deposits of iron-ore that are more cheaply mined, and more easily reducible in the blast furnace, and can, in short, be delivered at Canadian blast-furnaces more cheaply than comparable ores from known Canadian deposits, except in certain well-known Canadian operations. When the ore-supplies of the United States approach poverty, then Canadian ores will be turned to, just as Canadian forests are today being harvested for United States consumption.

"Economist" states with precision that it is from the United States that the keenest rivalry in iron and steel manufacture is to be expected for many years to come. There is no doubt about this probability.

So far as consolidation of Canadian coal and steel interests are concerned, it is a first law of successful iron companies to secure adequate coal resources, and this law has been followed and is still being followed by Canadian iron interests. As a logical evolution we believe also that Canadian steel companies will find it profitable, and probably necessary, to consolidate their resources as a defense against that same "keen rivalry" from the United States interests that "Economist" refers to. Moreover, it is to be doubted whether, except possibly in one instance, the most profitable or permanent evolution of the steel industry in Canada lies so much in an attempt to produce large tonnages of cheap basic materials, as in the development of an industry that will combine moderate tonnages with a specialized and high-grade product.

A Cutlery Industry in Canada

Some time ago "Iron & Steel" expressed the opinion that an opening existed for a cutlery industry in Canada, and recently the matter has again come to attention through seeing an advertisement of "Stellite" cutlery in United States papers. We believe we are correct in thinking that "Stellite," or the original combination of metals that was given that name, was an alloy of cobalt, chronium and tungsten, a peculiarly Canadian combination. We have in Canada every natural requirement for the making of high-class tool and cutlery steels. In fact, that should be Canada's especial province in North American metallurgy, and it is gratifying to know that some substantial advances have been achieved in this direction in Canada already.

Sheffield, the home of good cutlery, is swamped with orders, and cannot begin to supply the world demand. Germany is temporarily out of the running, but only very temporarily, if we know the Teuton. Japan's cutlery is not likely to prove a serious competitor to the United States cutlery firms, who are now turning out really excellent cutlery products, both as to style and cutting edge. There seems to be a very obvious opening for someone in Canada to take the place that before the war was almost entirely filled in the Dominion hardware trade by Henry Boker and Sons of Solingen, Germany. Quite recently a representative of this periodical visited every reputable dealer in cutlery in Montreal—including a branch of a well-known Sheffield house—for the purpose of purchasing if possible a set of manicure instruments and scissors that were **not** made in Germany, but such articles were apparently not on the market. We confess to a natural preference for a Sheffield blade, but if this is not available, a blade stamped "Made in Canada" would look very nice. Surely we could make as good cutlery here as was made in Germany. It is generally understood that Canada turned out some decent ammunition recently, and cutlery manufacture does not need anything like the skill and equipment necessary to manufacture, for example, a shell-fuse.

The Manufacture of Graphite Crucibles in Canada

By the courtesy of the officials of the Dominion Crucible Company of Lachine, Que., we are enabled in this issue to give a brief description and some photographs illustrating a new Canadian industry that has an important bearing on the future of Canadian metallurgy. The Dominion Copper Products Company was led to undertake the manufacture of graphite crucibles in connection with the manufacture of brass cartridge-cases, but the demand for crucibles has a fairly wide application in other branches of the metal trades, particularly in the manufacture of high-grade tool-steels and ferro-alloys, two industries for which Canada is exceptionally well equipped.

There is no duty on crucibles imported into Canada, except the 7½ per cent war-tax, and there is neither duty or war tax on crucibles imported from Great Britain. A duty of five per cent is imposed on Ceylon plumbago, if purchased in a British possession, and 10 per cent duty plus 7½ per cent war tax is charged for Canadian entry if the plumbago is purchased elsewhere than in a British possession. As all the dealers in plumbago in North America are located in New York, Canadian importers of Calyon graphite have been placed under a serious handicap.

Canada contains graphite in considerable quantity, but a certain amount of Ceylon graphite must be imported to mix with the Canadian product. As stated, however, by Mr. Maffre, graphite crucibles are important to many industries, their manufacture constituting what is now known as a "key" industry, and it is very desirable that now there is a fully equipped and successful plant in Canada, which during the war proved of indispensable assistance in the manufacture of munitions, and is now prepared to keep Canada independent of outside sources in the matter of crucible supply, the industry should at least be relieved of import duties on such of its raw materials as are unobtainable in Canada. Possibly also the question of some tariff protection should be taken under consideration by the Government. Crucibles are sold in Canada at the present time at an average price of eleven cents a number, a one hundred pound crucible selling for about eleven dollars.

EDITORIAL COMMENT

In a Centenary Supplement of the "Sheffield Independent" is given a list of 38 Sheffield firms, engaged in steel-making or steel fabrication, who have been established in the Cutlery City for one hundred years or more.

The firm of Marsh Bros., of the Pond Steel Works, was established in Sheffield in 1654. The well-known firm of Jos. Rodgers & Sons also dates back to the seventeenth century, but the exact date in the sixteen hundreds is not known.

A Cutler's Mark was granted to George Butler & Co. of Trinity Works in 1681, and the cutlery firm of George Wostenholme & Sons received its trade mark in 1694.

With this length of metallurgical experience and inherited skill behind its workmen, it is not surprising that Sheffield played such a decisive part in the supplying of munitions of war, or that the German Zeppelins tried so often and so desperately to wreak destruction on Sheffield works. Taking the much-bombed port of Hull as a point of orientation, it was not difficult for the Zeppelins to follow the valley of the Don to Sheffield, hidden in an amphitheatre of hills, but these same hills were well guarded, and only once did the Zeppelins reach Attercliffe, one of Sheffield's busiest—and blackest—manufacturing annexts.

Sheffield is a city which has always taken a great interest in technical education, and not only is the modern science of metallurgy linked up with names like Huntsman, Bessemer, Sorby, Arnold, and Hadfield, but it was the member for Sheffield that piloted the Compulsory Education Act through the Commons and founded the Board Schools, and later, in our days, Dr. Fisher, formerly Vice-Chancellor of the University of Sheffield, gave his name to the Education Act which passed the British Houses during the war, and is Britain's latest attempt to give all her people, without distinction of creed, race, or social status, an adequate education.

As the readers of "Iron & Steel of Canada" doubtless include sons of this Yorkshire city, which has made "whittles" since the days of the Saxon swineherd, this digression may be pardoned in one who confesses to a feeling of undiminished regard for the smoky, dirty, tortuous "Shevvild" that is a memory of youth.

The desire of the Senate of the United States to avoid European entanglements is natural enough. Yet the compelling forces which brought the United States into the Great War constituted in themselves the chief reasons why the United States, in splendid isolation, is a thing that has passed out of the circle of possibility.

The United States cannot hope to have the world as its market, and escape the responsibilities thereby occasioned. No nation, in the modern world, can live to itself. A Swiss politician recently stated, bluntly, but truthfully, that the position of a neutral in the late war was as irksome as that of a belligerent, and correctly asserted that those nations which did not declare themselves for one group of belligerents were considered to be against them. Where the issue is a moral one, the old saying stands, namely, that he who is not for the right is against it, and there is neither neutrality or discharge from the self-imposed task of the United States to make the world safe for democracy.

The modern world is one great city. London is as near to New York as San Francisco. The bubonic plague in the Ukraine is as great a menace to North America as the Asiatic influenza proved to be. The wind that blew from Russia has recently filled the prisons and deportation stations of the United States. President Wilson, when issuing his famous declaration of neutrality, said the United States was a mediatory nation, which, if it meant anything at all, meant that the peoples who made up the United States could not escape from mediation in the affairs of the rest of mankind, and mediation connotes entanglement and shared responsibility, as history records.

To some extent, Bolshevism, at least in its academic aspects, and considered apart from the primeval wickedness and bestiality it has disclosed as lying dormant in men, is a revolt against overdone nationalism; and if one lesson from the war should be clear and unmistaken, it is that all men, irrespective of nationality, are interested in the prevention of future wars.

Mr. Balfour has said: "Those who criticise the "League of Nations have no substitutes for the League "of Nations. They are prepared, it seems, for the "civilized world to go on in future as it has gone on "in the past, oscillating between those scenes of vio-"lence and sanguinary disturbance, and the intervals "in which great and ambitious nations pile up their "armaments for a new effort. To me such an ideal "seems absolutely intolerable, and I am not prepared. "seriously to discuss with any man what the future "of international relations should be unless he is pre-"pared either to accept in some form or other the "League of Nations, or to tell me what substitute he "proposes for it."

Apropos of Mr. Emmanuel Mavaut's article in our October issue dealing with slag aggregates in concrete and mortar, there will be found in this issue—re-printed from "Iron Age"—the summary of a paper read before the Cleveland Instiution of Engineers (England) by Dr. J. E. Stead, the distinguished English metallurgist, on "Blast-furnace slag in Concrete and Re-inforced Concrete."

We do not consider that the possible uses of slag have either been considered or developed in Canada, except for the manufacture of fertilizers, and, in a desultory manner, for road-mending material.

London cables to Canadian papers are amusing, and predicate in their senders an ingenuous belief in the credulity, or ignorance, of Canadian readers. A recent example was an announcement that the New Year Honor List would contain no Canadian names, the announcement being accompanied by suitable moralizing. Right on the heels of the announcement came the Honor List, with Canadian names thereon. Before one can fathom the inwardness of London cables to Canadian newspapers, it is necessary to know the politics of the sender, of the receiver, and quite a few other things. They seem however to be able to achieve the minimum of probability and the maximum of error, and are anything but flattering to the intelligence of those who read Canadian newspapers.

The O. B. U. in the Canadian West, it will be very generally admitted, are not a desirable collection of citizens. The probability is fortunately that they are not citizens, but merely residents in Canada. Nevertheless, we find it difficult to see the inherent correctness of an arrangement, made—if newspaper reports are correct—with the approval of the Federal Government at Ottawa, that none but members of the United Mine Workers of America are to be allowed to work in the western collieries. The United Mine Workers of Canada has some saving graces by comparison with the O. B. U. adherents, but the U. M. W. is not a legally incorporated body in Canada, or anywhere else for that matter, and it is going very far to dictate to any man that he must belong to an organization, irrespective of his personal desires. Different times, different manners, is a truism of these days, but the enforcement of the closed shop by government edict is something new, and, we believe, something that is very dangerous, because it is based on a fundamentally erroneous principle. Not even the most pressing problems can condone expediency.

In his address to the shareholders of the South Durham Steel & Iron Company, recently, Lord Furness said:

"It is admitted by competent experts in metallurgy "and fuel economy that the correct method of making "steel in the ordinary cheap trades is by mass pro- "duction, and this should be done in a conveniently "placed unit consisting of coke-ovens, blast furnaces "and steel works in one plant, thus enabling the pig- "iron to be used in liquid condition and the surplus "gas from the coke-ovens and blast furnaces to be "used in the steelworks for power and heating pur- "poses."

REPORT OF THE ASSOCIATE COMMITTEE OF THE HONORARY ADVISORY RESEARCH COUNCIL AS IT RELATES TO IRON & STEEL QUESTIONS

The following excerpts, concerning the iron and steel industries, are selected from the recently published statement of the Associate Committee on Mining & Metallurgy:

Iron Ores—A Sub-Committee under the chairmanship of Mr. J. G. Morrow has been formed to consider the Canadian ore situation and to recommend such further investigations and developments as may seem advisable. This committee is now studying the subject and an early report may be expected.

Refractory Material—A Sub-Committee on Refractories under the chairmanship of Mr. Theo. Denis has been formed, with especial reference to Canadian magnesite and other suitable materials. This committee may be expected to report at an early date.

Powdered Coal—A Sub-Committee under the chairmanship of Mr. O. E. S. Whiteside has been formed to consider the question of the use of Powdered Fuels, and to make recommendations as to the expediency of having special investigations carried out under government auspices, instead of leaving the matter as at present solely to private enterprise.

Standard Reagents—The committee called the attention of the Department of Mines through the Advisory Council to the importance of being able to obtain in Canada standard reagents and standardized samples for metallurgical analysis. Early action has been promised in this matter.

Steel Making in British Columbia—At the suggestion of the members from British Columbia is was recommended that the advisability of establishing a local steel industry in that province be considered. This has been done by the British Columbia Government, and a printed report covering the matter is now available.

Galvanized Scrap Iron—Recommendations looking to the use of scrap galvanized iron and tin plate have been acted on by the Advisory Council.

GOVERNMENT ASSISTANCE TO SHIPBUILDING URGED BY CANADIAN BUILDERS.

Representatives of seventeen shipbuilding companies waited on the Government on January 7th to urge assistance to shipbuilding in Canada. They requested that, for a term of ten years, the Government should grant a bonus of ten dollars per displacement ton and ten dolars per indicated horse-power on steel ships built in Canada and completed after April 1, 1920.

Without this assistance, the delegation claimed, existing plants could not be continuously employed and the breaking up of the organization would necessarily follow. This, it was added, would throw large numbers of men out of employment and undo "much of the good which the Government had achieved by means of the encouragement given to the shipbuilding industry and in the employment of returned soldiers and men previously at work on munitions."

Sir George Foster, on behalf of the Government promised earnest consideration of the request for a bounty. It was agreed that the delegation should appoint a committee to confer further with members of the Cabinet.

The Dominion Crucible Co.—A New Canadian Industry

By R. F. MAFFRE

There have been many radical changes in the industrial life of Canada as a result of the World War. The imperative demand for munitions in enormous quantities caused a metamorphosis of the factories and workshops of the nation, and the spur of necessity augmented the efforts of invention in the endeavor to provide articles hitherto required only in small quantities or not at all.

The manufacture of plumbago crucibles was one of the "key" industries concerned in the making of munitions. As a result of the unprecedented demand for crucibles to supply the needs of those engaged in the manufacture of brass cartridge and shell cases and copper driving-bands for shells, the crucible-makers of the United States and Great Britain were literally swamped with orders, and stocks dwindled to the vanishing point. Correspondingly, the prices soared, and consumers paid four and five times the pre-war prices, considering themselves fortunate in securing crucibles at all.

The Dominion Copper Products Company of Montreal, was faced with the problem of obtaining crucibles, and, after considering the situation, decided to make its own crucibles. The Dominion Crucible Co. was, therefore, incorporated in October, 1916, and a plant was erected at St. John's, P. Q. Much of the machinery required had to be specially made, and this occasioned considerable delay in the completion of the plant. Owing to the shortage of ocean tonnage, lengthy delays were experienced in getting clay from England and plumbago from Ceylon and Madagascar, so that it was June, 1917, before an output was secured. From this time until the cessation of hostilities, and the consequent cancellation of orders for munitions, the entire output was absorbed by the Dominion Copper Products at its large plant at Lachine, P. Q. The amount of this output was 1,268,000 numbers, equivalent to a melting capacity of approximately 38,500tons of metal.

The return of peace-time conditions placed this output at the disposal of the trade in general, and Canadian-made crucibles were on the market for the first time, as, previous to the war, all the plumbago crucibles used in Canada were imported, mainly from the United States.

The crucible plant at St. John's P. Q., is capable of producing crucibles in sufficient quantities to take care of all the requirements of the Canadian trade. Crucibles range in size from the jeweller's crucible, with its capacity of a few ounces, to the tilting-furnace crucible, holding 1,800 pounds of metal. The chief ingredients of the paste from which crucibles are formed are plumbago and clay. The requisite qualities in a good clay crucible are—great plasticity, good bonding powers; low vitrification point; high fusion point; great strength when air dried and also when burned. As regards plumbago, different conditions of various grades are made, but in general it may be said that the resulting blend must have a high carbon content and a fibrous structure that will stand reduction in size by grinding without being destroyed in the individual particles. For this reason, amorphous plumbago is unsuitable on account of its granular structure. No Canadian clay has been found that is suitable for crucibles, but while a portion of the plumbago used, of special quality, must be imported, this material is found in large quantities in Canada.

General View of Factory of Dominion Crucible Co., St. John's, P. Q.

Pugging Machine, showing orifice and cutting-board in foreground. Crucibles are drying on racks preparatory to firing.

Top of Kilns, which extend from Basement. Firing is done on a lower floor.

Crucible-forming Machine, showing mould and forming tool in position.

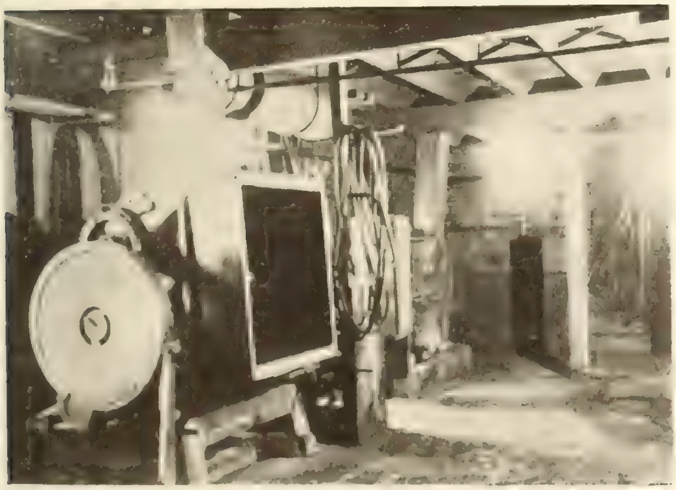
The making of crucibles is a branch of the oldest art in the world, the art of pottery, and the machine on which the crucibles are formed is an evolution of the potter's wheel of Biblical times. After the crucibles have been sufficiently dried they are burned in a specially designed muffle kiln which permits of their being subjected to an intense heat without coming in contact with the flames, smoke and gases of the fires.

This company is also making plumbago stoppers and nozzles for steel ladles and has supplied these to the majority of the steel plants in Canada, with the most satisfactory resuts. These articles were previously imported from the United States.

The quality of crucibles, stoppers and nozzles is an important matter to the metal trade, and there is considerable natural hesitation on the part of users to abandon goods in this line with which they are familiar in favour of a new line of goods of unknown qualities. Notwithstanding this, the "Dominion" crucibles, stoppers and nozzles are gradually establishing the fact that they can successfully compete in quality with imported goods but the future development of the industry will undoubtedly depend on being granted a sufficient protection against the foreign manufacturer to at least compensate it for the duty it is obliged to pay on the imported material employed.

Every new Canadian industry is an asset to the community at large, and it is hoped that the Dominion Crucible Company will receive sufficient encouragement to warrant a continuance of its efforts to establish this industry on a permanent footing.

The personnel of the Dominion Crucible Company is as follows: H. H. Vaughan, President; W. F. Angus, Vice-President; F. W. Evens, Secy.-Treas.; S. J. Kaufman, Works Manager, and R. F. Maffre, Accountant.



In foreground is the Mixer. In rear are seen the Burr-Mill and Sifter.

SMELTING OF MAGNETITES.

Those who were present at a discussion on smelting British Columbia magnetites which took place at the concluding session of the C. M. I. meeting in Vancouver recently, may be interested in the following brief, but sufficient letter:

The Editor of Mining nd Scientific Press

Sir—In your issue of December 6 is a communication from F. H. Mason in which he says that "the bulk of the accessible ore on the Pacific Coast is magnetite, which cannot be reduced by ordinary blast-furnace practice without an addition of more reducible iron ore".

This is so diametrically opposed to the fact of furnace practice that it cannot be permitted to pass without denial.

DWIGHT E. WOODBRIDGE.

Duluth, December 8.

The 110 Inch Plate of the Dominion Iron & Steel Company, at Sydney, Nova Scotia

By THE EDITOR

In the October issue of "Iron & Steel, contained in a short review of the plant extensions of the Dominion Iron & Steel Company, some brief particulars were given of the 110" plate mill now approaching completion. It is understood that rolling operations may be commenced towards the end of February. Since work was resumed on the construction of the mill, rapid progress has been made.

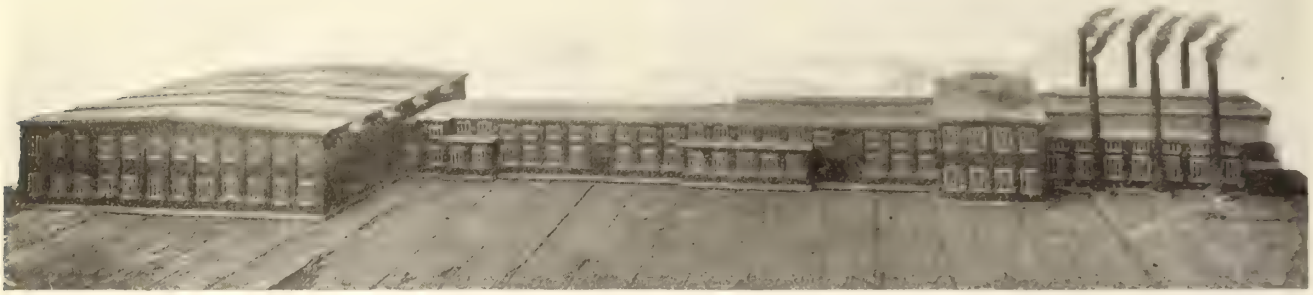
The acute shortage of shipping caused by the large number of ships which the German submarines sank before counter-measures by the Allies became really effective, made it necessary for the building of ships to be undertaken wherever possible, and the Canadian Department of Marine apprehending the necessity for shipbuilding, and also the opportunity offered to Canada to commence a new and necessary industry, entered with vigor into the construction of a mercantile marine owned and operated by the Government.

Today there is not the slightest doubt of the wisdom of this undertaking, and the only thing to regret is that when the Canadian Parliament saw fit to exculde vessels of foreign register from Canadian coastal trade before the war, it did not at that time undertake the obvious and necessary duty of subsiding the building of steel ships in Canada. The necessity for this step was vigorously urged at the time, but the opportunity was missed.

The Sydney plate-mill was a direct outcome of the Government's shipbuilding programme. The preliminary negotiations for the erection of the mill were very protracted, but eventually the Dominion Steel Corporation undertook the erection of a mill, furnishing its own capital expenditure, obtaining in return a contract for purchase of a guaranteed tonnage of plates at a price which was intended to recoup the Dominion Company for its large outlay, and to be in effect a subsidy. The original price fixed was $4.15 per hundred pounds for standard ship-plates, plus extras for unusual shapes.

The work on the foundation of the proposed mill was commenced in June 1918, and proceeded until May 1919. Contracts for the equipment and buildings were let, and committments were made totalling an ultimate expenditure of five million dollars. In the meantime the Armistice was signed, and the situation being easier in every way, and an altogether unjustified gloom having settled down upon the steel industry in North America, the Government sought a revision of the original guaranteed price for plates, the terms of agreement presumably contemplating—as most of the allied war contracts did—a sudden cessation of war requirements. The Steel Company and the Government were unable to agree on a revision, and work was stopped on the construction of the mill from May until July 11th, when it was resumed following the establishment of a new price of $3.65 per hundred pounds. The agreement, as revised, calls for 250,000 tons of plate delivered over a period of five years, with Government option to increase the tonnage to 375,000 tons; not less than 50,000 tons to be supplied annually.

Without desiring to enter any way into the matters which were the subject of debate between the Minister of Marine and the Dominion Steel Corporation, it is very evident that there is not as yet any place in the commercial life of Canada for the private operation of a shipplate mill of this magnitude, unless it is frankly aided by the Government, either by subsidies, or by bearing part of the expenses of construction. What the future may hold is another story, and we believe a very wonderful story, but there was every justification for the erection of a large plate mill in Canada and for generous assistance until such time as it may happen that a Canadian plate-mill can hold its own against the steel colossus of the United States, unaided and on its own intrinsic merits.



Miniature Model of General Layout of Plate Mill.

The new mill is a three-high, 110 inch, sheared-plate, motor-driven mill.

The motor is a 4,000 h.p. mill-induction type with direct connected flywheel, 82 revs. p.m., three-phase, 60 cycles, 6,600 volts, with 300 percent overload capacity. The floor-space occupied by the motor is 34 by 37 ft. and the combined weight of the motor and flywheel is 659,000 pounds. The roll train which the motor will drive is 36 inches by 110 inches, three high.

The mill is equipped to roll between 3/16ths in, to

110-Inch Plate Mill. General View Looking North.

2¼ inch gauges, in widths up to 98 inches and lengths up to 80 feet.

The rated capacity of the mill is 50,000 sq. ft. of half-inch plate in 25 hours, equivalent to 500 tons daily, and 12,000 tons per month.

Following are some general dimensions of the mill buildings: Slab-crane runway, 80 by 220 ft., Furnace Building, 140 by 227 ft., Mill Building proper, 80 by 250 ft., Conveyor or Hot Bed Building, 100 by 560 ft., Shear Building 300 by 350 ft. Total length of mill operation is 1260 ft.

The re-heating furnace for the slabs are regenerative, reversing, water-cooled, gas-fired furnaces, with inside dimensions 30 ft. long by 9 ft. wide and 7ft. high. They are designed to take eight slabs, 96 inches long, and to heat for rolling from the cold stock in three hours.

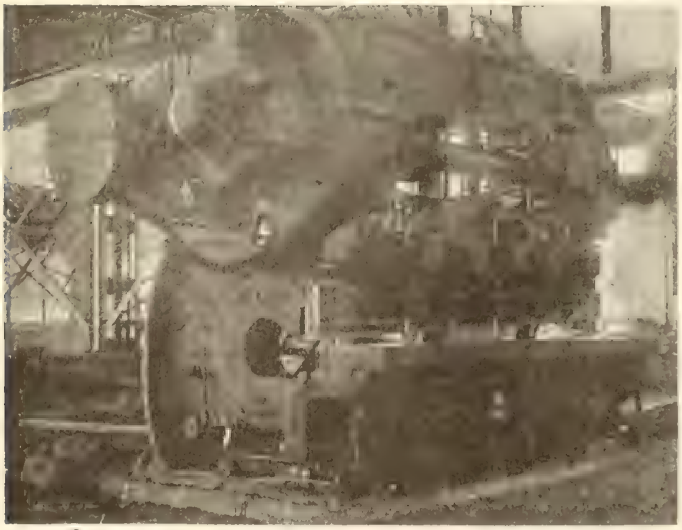
The plates are rolled from poured slab-ingots, the mill taking up a maximum slab of ten tons weight. It is understood that the ingots will be bottom-filled.

The construction of the mill has employed an average force of 600 men, and advantage was taken of a quiet period in steel demand to give work to the regular employees of the Steel Plant. The cost of the mill, with accessories it stated to total five million dollars.

As mentioned in our October issue, the power required to operate the Plate Mill has necessitated a large increase in the supply of electric current, particularly as a general scheme of electrification in substitution for steam drive was undertaken simultaneously with the erection of the Plate Mill. A new powerhouse has been provided, in which there has been installed one 5,000 kw. turbo-alternator, two 3,000 kw. turbo-alternators, and one 1,000 kw. motor generator. Wheeler surface condensers are used in connection with the turbines. Steam is raised by blast-furnace gases.

In addition to the above new equipment the Dominion Compny has greatly enlarged its fresh-water supply by impounding a neighbouring lake. Approximately a million dollars is understood to have been ex-

110-Inch Plate Mill. The Mill proper. Looking South.

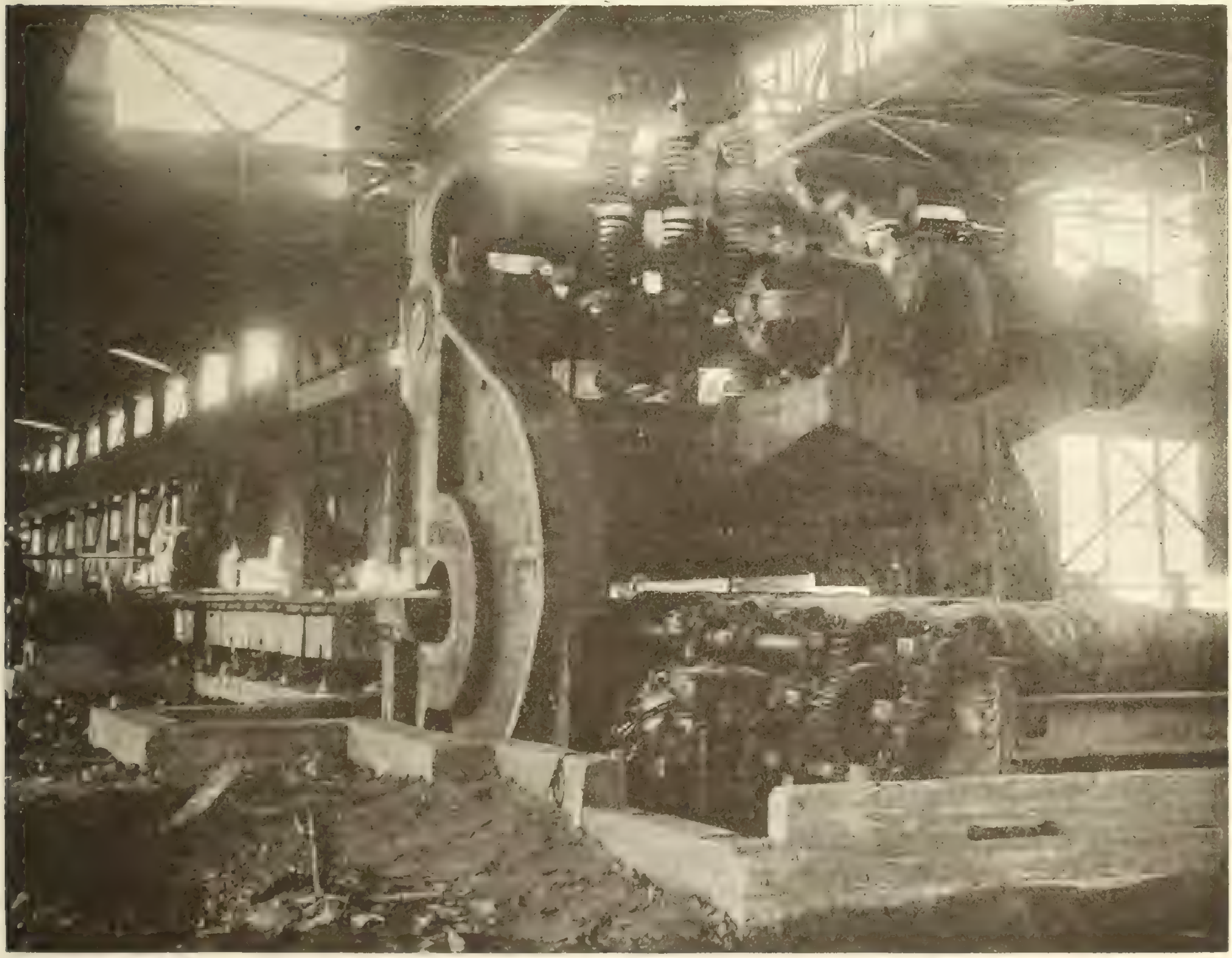


156" Slitting Shear.

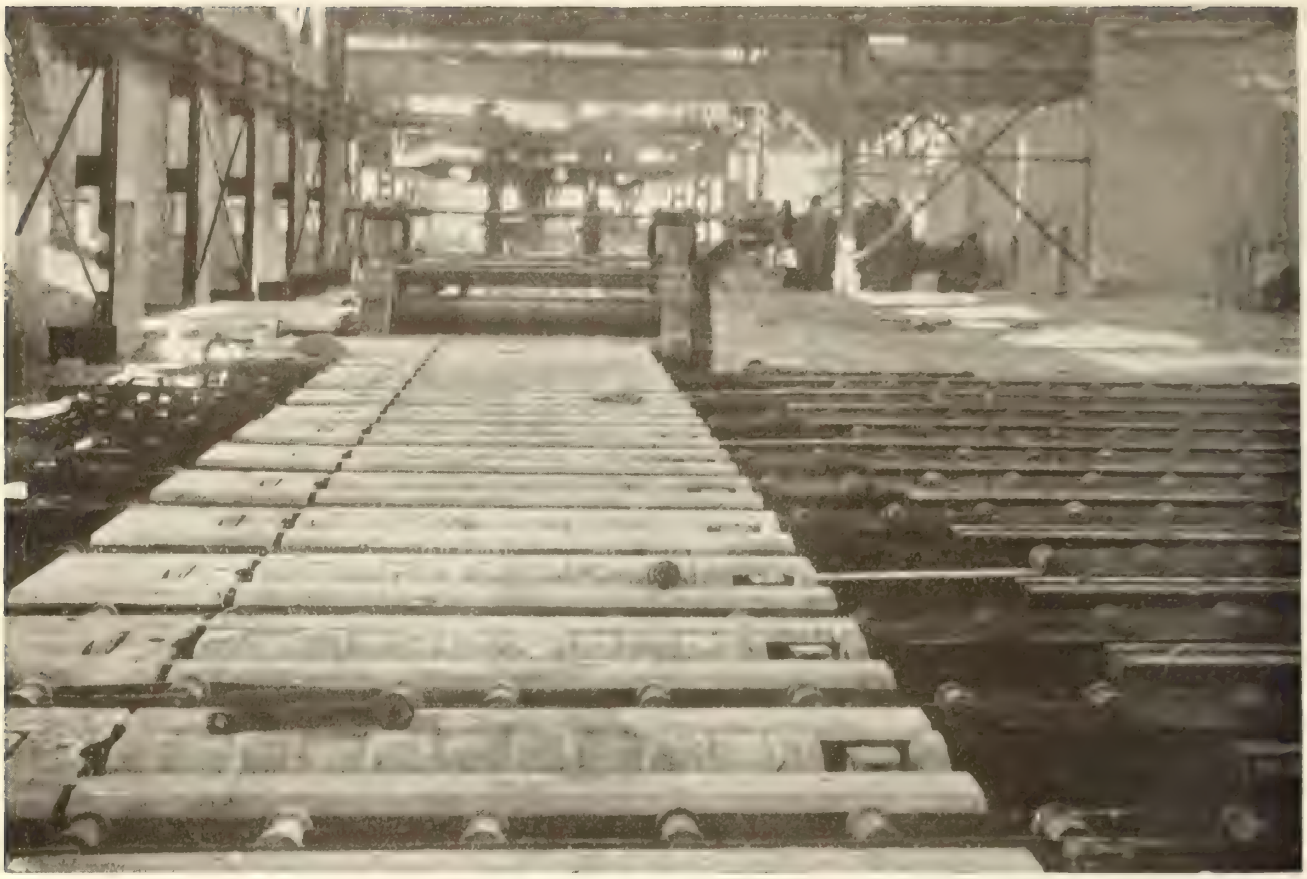
Inspection Table Looking South.

pended on this augmentation of the water-supply. Salt water is used wherever possible for cooling and condensation purposes, but the new coke plant requires a large daily quantity of water for quenching in addition to the other instances where the use of salt water is not permissible.

The original plant of the Dominion Iron & Steel Company was designed almost together with the idea of turning out steel rails in large quantity, but the demand for rails is so proverbially uncertain that from time to time there have been added finishing mills of various kinds. In addition to the Plate Mill, the Dominion Company now have a large and very completely equipped nail factory, a rod and bar mill, and the 16 inch mill used during the war for rolling shrapnel bars has lately been adapted to roll small rails and other commercial sections. It cannot, however, be said that the Dominion Company has, as yet, developed as many varieties of products as we believe the future will bring with it.



108″ Cutting-off Shear.



110′ Plate Mill. Section of Hot Bed and Straightening Rolls. Looking North.

The 4,000 H.P. Motor. Lifting into position the 65 Ton Stator Frame.

Canada's Part in the Iron and Steel Trade of the Empire

A recent deal by which capitalists of Great Britain have made an investment of several millions of dollars, and by which they are committed, it is said, to the investment of many millions more, draws attention to the part which Canada may play in the iron and steel trade of the British Empire in the near future. That the part she would play would in the course of time be prominent has not been doubted for many years past by those who grasped properly the significance of the enormous deposits of coal on the Nova Scotian seaboard and of iron just across the Gulf of St. Lawrence on the shores of Newfoundland, to say nothing of the deposits of ore and iron at different points from the Atlantic to the Pacific. Had it not been for the events of the past half dozen years, however, it is possible that Canada's day might have been longer delayed. As it is, it begins to look as though Canada might in the very near future prove one of the pivotal points upon which the industrial life of the British Empire will turn.

Previous to the war, Germany had become one of Great Britain's most formidable rivals in the iron and steel trades, the United States also occupying a prominent position in this connection. It is claimed that Germany is now out of the running for many years to come, more especially as the Allies, in settling up with their defeated rival, handed over to France a very considerable portion of the iron territory which had been the basis of Germany's commercial progress of the previous few decades. Germany still has iron mines of considerable extent, but these are not so advantageously situated for economic production as those upon which she formerly counted. While it is true that France in obtaining possession of these iron areas succeeds to one of the means by which Germany made her way to commercial power, there are reasons to doubt that France will for many years become a dangerous rival to British trade supremacy. Be that as it may, the United States is probably in a stronger position than ever to compete for the British markets. During the war she amassed great riches and developen her iron and steel industries to a wonderful degree. While it is true that much of this development will be of little use to her in competing along commercial lines, there can be little doubt that her industrial organization has been greatly advanced and the treasuries of the most of her iron and steel concerns have been strengthened to a degree hardly even dreamt of before the war.

It is from the United States, therefore, that the keenest rivalry is to be expected for many years to come.

To the extent that geography affects trade progress, Great Britain can place herself in a similar position to the United States by making herself a part of Canada. Geographically, the United States and Canada are one for many thousands of miles, from east to west; and although differences become more marked on a north and south comparison, it may be questioned if on this count the United States has advantage over Canada. The mileage separating Great Britain from Canada is actually less than that separating Great Britain from the United States, and during a considerable portion of the year the voyage can be made more quickly along the northern route. These advantages are possibly offset by the disadvantages at other periods of the year. On the whole, it would seem that if the British capitalist contemplates including Canada in his plan to combat commercial rivalry of the United States, he can do so on even terms so far as the situation is affected by geography and climate.

Of perhaps even greater value than the above considerations are those of natural resources—in this case deposits of coal and iron. It is true that Canada has no anthracite coal, but she has endless quantities of bituminous or soft coal, which is the great commercial coal, and of iron ore. These deposits are to be found at various points all the way from the Atlantic to the Pacific. But first and foremost, they are to be found almost alongside each other on the Atlantic seaboard. From a raw product standpoint, coal and iron hardly have to be handled by rail at all. So close to the seaboard are the deposits that they are actually being mined under the sea.

As to the quantity available, it is sufficient to say that the deposits are of such extent on the Atlantic coast alone that they cannot be exhaused during the present generation—and it is hardly necessary to worry beyond that. One experienced iron and steel man considers that Nova Scotia in respect to abundant supply of coal and iron ore at an economic shipping point, is the best situated country in the world.

Some years ago, Nova Scotia was deemed a long way from Great Britain. It took weeks to reach it by ship, and communication could only be had by letter. Today, a modern steamship crosses in a week at most. A few years ago it was only those of imagination who would venture to predict that the ocean trip would be made by air in a day or two. No imagination is now needed, for an airplane has crossed in a night-time. The day is coming when one may dine in the evening in the United Kingdom and breakfast next morning in Canada. As for communication, letters are now too slow even if delivered over-night. The underseas cable itself is being threatened with extinction. Instead, the message is carried, by telegraph, through the clouds in a few seconds, and the day is at hand when the voice will make the transatlantic trip none the less quickly. Distances are being annihilated, and the time is here when for all commercial purposes the few miles separating Canada from the United Kingdom will count for no more than the distance separating different parts of the United Kingdom.

When the truth of this fully takes hold of us, it becomes less difficult to perceive what consequences must follow thereon. It means that Great Britain will look towards Canada to an extent undreamed of heretofore for those raw products which she requires to keep her own industries operating; and that, as the raw product costs more to transport than the semi-finished, the proportion of the latter occupying space in the steamships will become ever greater as time goes on.

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The conditions alluded to being present, it would be a logical development for British capital to look upon the resources of Canada, not as something foreign to Great Britain, but as something within the Empire and situated right next door. During the war the dislocation to industries which were cut off from their accustomed base of supplies in enemy country, was one of the most disturbing factors, and in the various economic discussions for after-war developments which took place between the Allies, particular attention was paid to the need for the development of the natural resources and supplies of raw products lying within allied countries.

Canadians have been wont to speak of the wonderful natural resources and the illimitable supply of raw product to be found within the Dominion of Canada. Why, then, if they actually believe these claims, should there be such skepticism regarding the investment of a few millions of British capital in one of the basic industries—iron and steel? The report was that the expenditure of some $10,000,000 or $15,000,000 on improvement and reconstruction at the plant of the Dominion Steel Corporation would follow upon the investment of some millions in shares of this concern. Truly the expenditure of $10,000,000 or $15,000,000 on this plant, instead of being looked upon by Canadians as an extravagant undertaking, should be looked upon as the very least of the consequences following upon the deal mentioned.

Without any special knowledge of the details of the deal, it would require only a logical mind to reach the concusion that the expenditue to follow upon such a development should be more like $100,000,000 or $150,000,000 than one-tenth of that amount. Instead of the sum originally mentioned being extravagant, it must surely represent the merest initial expenditure in an industrial development which should become in the course of the coming few decades one of the largest in the British Empire. Either that, or we all are only repeating grotesquely exaggerated statements when we talk of the wonderful iron and coal and mineral deposits, the vast inland waterways, the enormour waterpowers, timber resources and wheat lands of Canada and the need of the world for the products of this country.

To see this matter in its true perspective, not less imagination is needed but a little more imagination. In the early part of the recent war, the announcement that the Canadian Car and Foundry Co. had booked a contract with Russia for shells to the value of $8,000,000 or $10,000,000 caused subscribers to a financial publication to call up the editor of that publication on the 'phone and threaten to cancel their subscriptions unless he exercised more moderation in his efforts to dispel the gloom. The editor replied that instead of exaggerating the amount of the contract he had minimized it, and that the actual amount of the contract was more like $80,000,000. And that was actually the case. Big situations call for big conceptions, and there is every reason to think that a big situation now confronts Canada.

It is not easy to arrive at the exact truth of what is transpiring in England with respect to Canadian industrial development. We know that Canadians of undoubted capacity and financial strength are at work in London and are attracting attention to the opportunities lying more or less dormant in Canada. The deal in Dominion Steel Corporation is the evidence of this. Cables from London intimate that further developments are likely to follow, and while some of the developments hinted at have been more or less denied in other quarters, some of the denials fail to carry conviction.

After all, to reach a reasonably correct conclusion, one has but to ask what developments should follow upon a deal of the character mentioned—always assuming that the British interests brought into the deal are the right people. The developments which should follow are those which must follow. If they do not follow now, they will later; and if they do not follow now, the reason is likely to be that the interests concerned fail to grasp their opportunities.

Among other things, it is denied from London that there is any intention of bringing the Nova Scotia Steel and Coal Co. into the present deal. The wisdom of this decision would largely depend upon what the Scotia Company had to offer and the price demanded. There can be no doubt that if the Scotia Company possesses anything like the resources of coal and iron claimed some time since, these can be developed more advantageously if operated in conjunction with the Dominion Steel Corporation and under one direction than if developed separately and in opposition thereto. That is to say, that whatever may be the actual value and earning power of the shares of each company under separate management, these should show an increase under the economies to be effected under one management or direction. The product of the two concerns shows a great deal of similarity, so much so that officials of each concern have expressed the view that no great advantage, in the way of reaching new markets or markets for a wider range of products, was to be gained through consolidation. It should not be forgotten, however, that there have been antagonisms between the two companies, and that these alone would interfere with a candid recognition of the advantages or disadvantages of the situation Hence, it is not surprising to read that there is no intention on the part of the new group in Dominion Steel Corporation to include Nova Scotia Steel and Coal in their plans of development. At the same time, it is interesting to report the opinion of one who has been fairly close to these developments that an understanding already exists between leading interests in each company.

* * *

The name of Steel of Canada does not appear to have been mentioned in the cable despatches as being included in the plans of development of the new English group. Yet we know that there have been negotiations between leading interests in Dominion Steel Corporation and Steel of Canada. What became of these negotiations is difficult to say. Certainly some of the largest interests in the Corporation were as friendly to negotiations with Steel of Canada as they were antagonistic to negotiations with Scotia. Furthermore, from an industrial standpoint alone, the amalgamation of these two concerns made its appeal. Steel of Canada, speaking generally is the complement of the Dominion Steel Corporation, furnishing the finishing mills for the raw or semi-finished product of the Corporation. It has even been stated by officials of the Corporation that the requirements for expansion and for taking full advantage of its position as

a producer of iron and steel would compel the Corporation to build its own finishing mills unless these could be otherwise obtained. The finishing mills of Steel of Canada are a natural evolution and are situated mostly in the populous centres of Ontario and Quebec, just where they are required. The company owns iron and ore fields in the United States, but none in Canada. The Dominion Steel Corporation owns iron ore and coal, but not the finishing mills. It is unlikely that these two concerns, in a comprehensive scheme, should remain apart. Their amalgamation would seem to be among the first developments called for under the new order of affairs.

A further step westward brings into the consideration yet another iron and steel concern, namely, the Lake Superior Corporation. Here we have a company with a somewhat chequered career. It was the conception of a man of vision and capacity, but with possibly too small a percentage of the practical element to hold him in check. At any rate, he seemed to be a little ahead of his day. Yet, that was only a few years ago, and already the Lake Superior Corporation is rapidly coming into its own. Here we have a company owning iron ore deposits and operating furnaces and rail and structural mills. In fact, it is the only company rolling large structural shapes in Canada. It is situated on the Great Lakes, at the Soo, and thus has excellent transportation facilities at its disposal. At the same time, it is half way across the continent and in a better position, in this respect, than the other concerns mentioned to attend to the requirements of the West. Quite possibly it could supply Steel of Canada with some of its requirements more advantageously than could the Dominion Steel Corporation.

It would seem that any group capable of taking hold of the iron and steel situation of Canada and developing it in a truly economic and national manner could not overlook any of these companies in its plans. To stop short of this would be to leave too many loose ends and lose too many opportunities.

At the time of the formation of the Canada Cement Co., the promoter, replying to a criticism, pointed out that irrespective of the ruinous price-cutting taking place in the competition between the independent companies, a fortune was being wasted annually by unnecessary transportation costs. The various concerns were weakening themselves paying freight on cement shipped by them into each other's territory. Under the amalgamation, this foolishness would cease, each company would supply its own market and the funds spent in unnecessary freights would be employed for cheapening the cost of production or would be paid out in dividends to shareholders. This prediction has been fulfilled, and the holders of Canada Cement shares are getting 6 per cent dividends in spite of the fact that the duty on cement has been lowered.

The promoter of that company, now Lord Beaverbrook, also put the Steel Company of Canada together, as well as the Canadian Car and Foundry. Lord Beaverbrook now lives in London, and the general belief in financial circles in Canada is that he is a prime mover in the deal by which British capital has become interested in the Dominion Steel Corporation. Change of residence has apparently not lessened Lord Beaverbrook's interest in Canadian development, but has added greatly to his power to bring this development about. He has hardly forgotten his early lesson on the advantage of saving transportation charges on unnecessary movements of freight. The opportunity seems wide open to him, situated as he now is, to accomplish an enormous saving in this item alone for the different iron and steel companies of Canada by bringing them all into a holding company.

Iron and steel men who have given the matter considerable thought are convinced that great advantages would follow a union of this nature and that the various companies would be greatly strengthened thereby, that costs of production would be much reduced, and that only through a large combination of this character will Canada be able to hold her own in the markets of the world. This being the case, it would not seem a wild stretch of imagination to predict its accomplishment in the natural order of events, following upon what has already taken place. In that case we will shortly cease talking of expenditures of $10,-000,000 to $15,000,000 as something to be wondered at. Iron and steel producing machinery and processes are pretty much out of date in ten years anyway. Charles Schwab scrapped a million dollar plant without even completing it, we are told, in order to introduce a yet newer process. If we really believe in Canada and her wonderful opportunities, we will have to get over the habit of talking in small figures like $10,000,000 or $150,000,000. That was good enough once when money was worth something and we had to go abroad every time we wanted to borrow a million. Now we subscribe internal loans of $500,000,000 a year without turning a hair. Let us take our measure from that phenomenon.—By "Economist," in Toronto Saturday Night.

STEEL OF CANADA ON SEVEN PER CENT DIVIDEND BASIS

Steel Company of Canada has placed its common stock dividend at 7 per cent by declaring a 1¾ per cent dividend for the last quarter of the year, and adding an extra ¾ per cent to previous dividend payments during 1919.

The common stock was first placed on a dividend basis in 1916 when 4 per cent was paid. In March, 1917, a bonus of ½ of one per cent was added, which was confirmed by declaration of a six per cent rate in September, 1917. This rate has been maintained until the recent increase above-noted.

DOMINION STEEL COMPANY TO MANUFACTURE FIRE BRICK

It is understood, on good authority, that as a result of experiments conducted over a number of years past, the Dominion Steel Company contemplates the erection in the near future of a plant to make fire-brick and shapes from local materials for use in its metallurgical processes and coke-ovens, which are at the present time necessarily imported. The expenditure contemplated is said to be in the vicinity of $250,000.

It is probable that the extensive deposits of silica of good quality which occur near Whycocomagh, Cape Breton Island, will be drawn upon, and possibly also the limited area of kaolinic clay which is found near Coxheath Mountain, not far from Sydney.

COMPANY NOTES

PRESIDENT OF "SCOTIA" REVIEWS OPERATIONS OF 1919

Reports Purchase of Coaling Plant, Lumber Areas and the Acadia Coal Co.

The year 1919 saw considerable depression in the operations of the steel plants of the Nova Scotia Steel and Coal Company. At the beginning of the year, a large amount of business of an ordinary commercial nature was on the books of the Company, a great part of which had accumulated during the war period. It was hoped at the beginning of the year, that the practical cessation in the manufacture of steel products for commercial purposes, which existed for several years previous, would cause a continued demand for steel products during the whole year. This hope, however, was not realized; but, on the contrary, the first of July found all the steel plants of Canada with very little business on their order books. This opportunity was taken by the Scotia Company to reline its blast furnace, which had been in continuous operation since 1914; to rebuild its open-hearth furnaces; and, generally, to overhaul its several steel plants which had been working to the limit of their capacity during the war. The outputs of the steel plants were therefore much reduced, as compared with any year since 1914.

At the collieries, the demand for coal, which for the four years previous had been unprecedented, fell off alarmingly, and by the first of March all the collieries of the Province were working on half-time or less. This situation continued, as far as the steel plants were concerned, until the very end of the year; but about the first of November, when the relining of the blast furnace was completed, business began to improve, and the close of the year finds the Company with a very satisfactory amount of business on its orderbooks. The prospects for the coming year are satisfactory; the railways of Canada, which for several years have curtailed their purchases of rolling stock and track equipment, showed some evidences of coming into the market, and already some very considerable orders have been placed for steel material.

The coal situation began to improve somewhat earlier in the year, or about the middle of August, and until the present time the demand for coal which was accentuated by the strike in the United States, has continued to keep the collieries of the Company in full operation. While the exceptional demand for coal created by the American coal strike has somewhat abated, the operations of the Company's steel plants will require a large percentage of their coal output at Sydney Mines, and there is every indication that the collieries will operate more steadily during 1920.

At the present time operations at the collieries are somewhat curtailed, by the unrest consequent upon the establishment of the Conciliation Court, to consider a demand for a general leveling up of wages. The great problem which at present confronts the mine operators of Nova Scotia, who are also steel manufacturers, is how, with the continually increasing cost of coal, it will be possible to keep their steel plants in operation and compete in the general steel market.

Three Important Acquisitions

During the year, the Company made three very important investments which we have every reason to believe will prove of inestimable value.

For the past ten years, the Company had been carrying on lumbering operations in Pictou and Colchester counties, and has acquired quite an extent of timber properties. In November, they purchased the extensive holdings of Messrs. Rood and McGregor, in Pictou county, comprising some of the finest spruce in the province of Nova Scotia, and insuring for many years a certain and easily accessible supply of lumber for the rapidly increasing requirements of the Company, and its various subsidiaries. This is one of the largest lumber deals consummated in the province in recent years.

Ensures Close Co-operation

The third and most important purchase made by the Company was the acquisition in the early part of the month of a controlling interest in the Acadia Coal Company, Limited. The purchase of this interest by the Scotia Company will lead to very close co-operations between the two companies. Not only will it insure a supply of fuel for the works at Trenton, but it will doubtless enable operation at full capacity of the extensive power plant at the Allan Shafts, in supplying electric power to the Steel Plant and the Car Works. This latest move by the Scotia Company, which makes for closed large concerns, is, we believe, a source of great gratification to the people of Pictou county and the province generally.

Summing up, we feel we can truthfully say, that the year 1919 has been a very successful one in the history of the Scotia Company, and a harbinger of prosperity and progress in the future.—Halifax "Chronicle."

The president of the Steel Company of Canada, Robert Hobson, has issued a denial at Hamilton, Ont., of the report that the company was threatening to locate a blast furnace in Port Colborne because of a dispute with the city over Pollock's Lane. The company has decided to erect a $2,000,000 blast furnace and it might be located at Port Colborne because the company is cramped for room in Hamilton.

Because of the refusal of the employers in the structural steel section of the building trades industry to recognize the local union of structural steel workers in Toronto, the negotiations which are proceeding between the sections of the industry and the nineteen unions may be delayed. The unions of the industry with influence must obtain this recognition for the structural steel workers if there is to be a settlement of agreements in the building trades industry on Jan. 1 of a permanent character.

The National Steel Car Corporation, Limited, of Hamilton, Ont., recently organized under a Dominion charter, has taken over the plant, business, equipment, assets and liabilities of the National Steel Car Company, Hamilton. The new company is purely Canadian in every sense of the word, having as president, R. J. Magor. The National Steel Car Corporation, Limited, will continue to manufacture railway

cars, having on hand two large orders and others about closed, and the motor truck department will have a greatly increased capacity. The minimum production for the coming year is placed at 1,500 motor trucks.

Believing that the cause of industrial unrest in the world is largely due to unfair profits being made by capitalists, T. J. Storey, President of the International Metal Works, Limited, Brockville, Ont., has decided to share the profits of the concern with the employees. On last year's profits, it was announced, each man's share would be about $300.

E. A. Wilson of the Ingersoll Machine Co., Limited, has joined with the John Morrow Screw & Nut Co., Limited, in Ingersoll, Ont., and will be Vice-President and joint manager with J. A. Coulter, the head of the Morrow Company. It is also announced that the Morrow Company has purchased an interest in the Ingersoll Machine Co., Limited, and the American Machine Products Co., Incorporated, of Detroit, and will, with Mr. Wilson and Mr. Munger, formerly of Ingersoll, operate them, together with the Ingersoll File Co. as subsidiary companies to the John Morrow Screw & Nut Co., Limited. At the plant of the Ingersoll Machine Co. some $50,000 worth of new machinery is being installed to make a line of tools not previously made there. Col. F. H. Deacon of Toronto, Honorary President and director of the board, will devote considerable of his time to the development of the industries in Ingersoll.

The newly organized Farmers Standard Carbide Company at Freydenburgh Falls, N.Y., have employed Messrs. W. E. Moore & Company, Engineers, Pittsburgh, Pa., on the construction of their new carbide plant. This plant will be equipped with a Moore 3-phase carbide furnace, with a capacity up to 30 tons per day. The 46' water fall will be developed for a capacity of 3700 h.p. Crushing, screening, can-making machinery are being designed and will be installed to correspond.

Following the vote of the Sarnia Indians to dispose of 1,184 acres of their land along the St. Clair River front for the sum of $200,000, S. A. Howard, a Detroit banker, announced that preparations were now well under way to build a $15,000,000 steel plant in Sarnia alongside the property owned by the Wills-Lee Auto Corporation interests. The Indians, after a long consultation, have decided to surrender their reserve lands to the extent of the above number of acres to be used for industrial purposes and for the erection of a steel city under the present Ontario Housing Act. Work, it was stated by those behind the venture, would be started on March 1. Among those associated withe the Detroit banker are J. J. Mahon of the Imperial Munitions Board of Canada and a number of other prominent Canadian and American steel magnates whose names will likely be made public in a short time. Negotiations had been opened with the town of Goderich looking toward the location of the plant there and the selection of Sarnia as the site has caused a great deal of disappointment in the northern town. When Sarnia was announced as having secured the plum the town took on the semblance of a rush to a mining district in boom days and the real estate men got as busy as bees. Three hours after the deal was made public one $10,000 land deal was reported, while a number of business men and others on Front Street have been asked for figures on their stores.

Judgment issued by Mr. Justice Kelly refuses an order to wind up the Imperial Steel & Wire Company of Collingwood. "The circumstances, unsatisfactory as they appear in some respects, do not warrant that course at the present time," he says. "There is uncontradicted evidence that the company has procured or can readily procure, contracts productive of profits as soon as its plant has been put into condition to resume operations. I am unable to say, therefore, that the situation necessarily calls for a winding up on the ground that it is just and equitable that the order should be made, and I think, therefore, that both applicants should be dismissed."

TIN REFINING IN BRADFORD, ONT.

A new and important Canadian industry.

A Canadian company has been incorporated under the name of the Electro-Tin Products Co., Ltd., and a plant has been erected in Bradford, Ont., to manufacture tin products. The tin will be refined from Bolivian ores by an electric furnace process, named the "Cobb process" after its inventor. A capacity of two tons of refined metal is expected from this furnace daily. In view of the large market for tin now existing in Canada, this latest addition to the range of Canadian metallurgical industries is important.

Tin--plates will soon be a product of importance in Canada, and it is understood that a production of close to 40,000 tons of tin-plate, and of black and galvanized sheets,, would be possible with the operation of the eight mills which Baldwin's Ltd. are installing as a first unit in Toronto, and that an ultimate production of 200,000 tons annually is contemplated.

It is also understood that the Dominion Sheet Metal Corporation of Hamilton has a capacity for the production of galvanized sheets at the rate of 14,000 tons annually, and that extensions which will be completed by the beginning of 1920 will make possible an annual output of 20,000 tons.

In addition, the Steel Company of Canada has a capacity of 10,000 tons a year, and is manufacturing as closely as possible to capacity.

It is also expected that the Ojibway Plant of the U. S. Steel Corporation will include tin-plates and sheets in its products.

The first tin-ingots from the Brantford plant were shown in that town on December 18th. and were stated to analyse 97.7 pure tin.

NOVA SCOTIA STEEL & COAL COMPANY'S PRODUCTION IN 1919.

An approximate comparison of the production of the Sydney Mines collieries and steel-works for 1919 and 1918 is as under:

	1918 Tons	1919 Tons
Coal	502.018	557.000
Iron	92.000	36,000
Steel	129.000	60.000
Coke	110,000	45,500

The blast furnace and open-hearths at Sydney Mines are working to capacity, as is also the New Glasgow Plant.

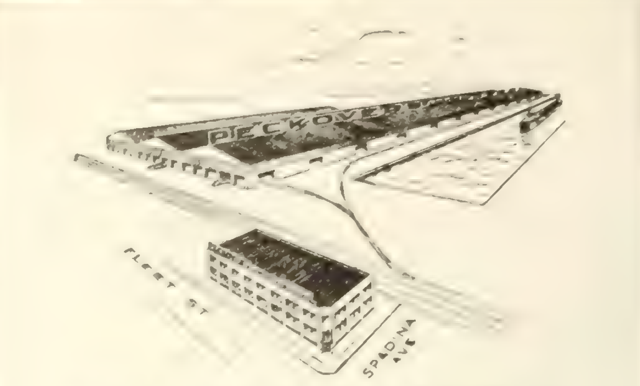
PECKOVER'S LTD. TO ERECT STEEL WAREHOUSING PLANT IN TORONTO

A new company has been organized in Toronto under the name of Peckover's Limited for the purpose of carying on a warehousing, jobbing and importing business. The new firm is capitalized at half a million dollars with $300,000 paid up capital, is well officered and is starting off under the brightest auspices. Temporary premises have been secured on the Esplanade and have been adapted to steel warehousing and these will be open to business on January 2nd. Already over a thousand tons in mill deliveries are on the way in the line of steel and iron bars, nickel, steel, tool steel, galvanized black and automobile sheets, plates, structurals, boiler tubes, etc.

The new premises are excellently located at the foot of Spadina Avenue and comprise three acres in the heart of the business section of the city. Besides an excellent dock, railway facilities will be furnished by three lines which will pass the premises, the C.P.R., the G.T.R., and the C.N.R. These facilities will enable the new company to get water delivery from Algoma, Hamilton or the mills in Nova Scotia, as well as from U. S. points and eventually from European centres.

Two well known men in the steel industry head the company. C. R. Peckover, of the firm of Baines & Peckover, has been in the steel business in Canada for some years. He came to Canada about 23 years ago after studying steel in Scranton. Following a brief engagement with the Rice-Lewis Company he went into business with Mr. Baines as agents for the London Rolling Mills and for the London Bolt and Hinge Works. The firm of Baines & Peckover developed to large proportions and through his association with the cmpany and ability Mr. Peckover is well and favorably known in the steel trade in Canada. As a traveller and as a successful steel merchant, he has visited nearly all the large steel mills and warehouses in Europe, Canada and the States, and has been brought into close contact with the trade in its various branches.

J. G. NEAR.
General Manager Peckover's Ltd.



[illegible] WAREHOUSE OFFICE AND DOCK OF PECKOVER'S LTD AT FOOT OF SPADINA AVE.

The general manager of the new company is J. G. Near, a Toronto boy who is well and favorably known in business circles. He was for 18 years with the Drummond-McCall Company and played a prominent part in the development of the warehouse department of that institution of which he had charge for some time. Latterly he was in charge of the sales department. It is recalled that a few years ago Mr. Near was a well-known Canadian runner, having won the Marathon in Toronto in 1909. He was a runner-up in the Boston Marathon and was third man across the tape in the Hamilton Road Race.

Associated with Peckover's Limited will be Steel Working, Limited, with a full equipment of fabricating shop machinery, which will be in operation in January under a competent and experienced staff in office and shop.

Every modern equipment will characterize the Spadina Avenue warehouse, the company planning to make it a model one in every particular. There will be installations of electric cranes, shears, saw, etc., for the most rapid handling and cutting of steel to length or shape desired. The buildings will be 200 feet wide by 600 feet long. Round bars will be carried up to 18 in. diameter, 1 beams up to 24 in., UM plates to 72 in. wide, with a full stock of angles, channels, tees, merchant bars, sheets and sheared plate advancing in 6 in. widths, and a heavy stock of boiler tubes 1 in. to 4 in.

NEW COMPANIES INCORPORATED

Letters patent have been issued incorporating F. B Common, F. G. Bush, H. W. J. Jackson, G. R. Drennan and W. P. Creagh of Montreal as the Edgar Allen & Co. (Canada), Limited, for the purpose of dealing in steel, iron, metals, metallic combinations, etc., and to carry on the business of steel and iron manufacturers.

A Winnipeg Company, known as the Western Wheel and Foundries, Limited, has been formed and granted a charter to carry on the business of manufacturers, merchants, miners, contractors, engineers and machinists. The incorporators are J. A. McVicar, A. T. Hawley, N. J. D'Arcy, J. G. Chanter, A. B. Rosevear, all of Winnipeg.

NEW FOUNDRY ORGANIZATION AT SHAWINIGAN FALLS

A new venture, or rather a development of two already in existence, has been inaugurated at Shawinigan Falls, and commenced operations on January 1st. During the period of the war Fraser Brace & Co. erected and operate an electric furnace plant for the production of pig-iron which was situated in close proximity to the iron foundry belonging to Normandin Brothers. These two concerns have been acquired by new interests and will be operated under the title of "The Shawinigan Foundries Ltd." It is intended to continue the manufacture of pig-iron in one electric furnace pending developments which may lead to the production of ferro-alloys and special steels in the near future. Extensions are contemplated so as to enable the Iron Foundry to cope with a large and increasing demand for the ordinary run of castings required in such a busy industrial centre. Arrangements have also been completed for carrying on the brass foundry work on a larger scale than heretofore, and to put a special grade of semi-steel casting upon the market. The plants will be equipped to execute orders for pig-iron, steel, semi-steel, gray-iron, brass, and bronze; for all of which there is an excellent demand in the immediate district. The amalgamation and development of these two concerns may be taken as an indication of present day tendencies, under the influence of which manufacturers are seeking centres in which power can be obtained at reasonably cheap rates. The new organization has been incorporated as a private company with Mr. C. G. Macartney (who operated the electric foundry for Brace & Coy) as President; Mr. W. G. Dauncey as Vice-President and Metallurgist; and Captain C. M. Hall as Secretary-Treasurer. Mr. Dauncey is well known to our readers in connection with many activities associated with the iron and steel industries. When acting as Consulting Metallurgist for the Canadian Steel Foundries he designed and developed the 6-inch, 8-inch and 9.2-inch steel blanks for high explosive shells and later had the satisfaction of knowing that his work had been adopted as standard. Prior to this he introduced a new, and special, type of malleable iron into the States, and was, with Professor Stansfield, responsible for the editorial work in connection with "Iron & Steel" of Canada during the first sixteen months of its existence. In a brief interview Mr. Dauncey said "During the four years I have been in "Canada I have been greatly impressed with the pos-"sibilities of the iron and steel industries. There is "no country in the world more bountifully supplied "with the necessary alloying elements for the produc-"tion of special and high grade steels, and I anticipate a rapid and extensive development along these "lines. The history of the industry can be separated "into three periods. The first and initial period cov-"ered the time when iron and steel of indifferent qual-"ity had to be accepted for want of something better. "The second period was entered upon when steel to "a close chemical specification had to be produced "for munition purposes, for the physical characteris-"tics could not be obtained unless the constituents "were properly proportioned. The third period is "now here, and metallurgists, engineers, and machin-"ists must work together to produce the most suitable "material, having minimum weight with maximum "service, and reduced machining costs. It is now "realized that cast iron, malleable cast-iron, semi-"steel, steel, and wrought-iron each have their par-"ticular fields of usefulness, fields in which each in-"dividual alloy should be fuly expoited to the exclusion of the others.

"We hope in our Shawinigan Foundry to be able "to suit the composition of our casting metals to the "service required."

LARGE EXPORTS OF STEEL-PLATES FROM U. S. DURING 1919. CANADA SECOND LARGEST PURCHASER.

The exports of steel plates from the United States up to Oct. 1 were at a rate exceeding anything attained during the war. War exports of nearly all steel products were phenomenal, but the foreign demand for many of them has subsided in the past year or at best has not much more than kept pace with the war record. Steel plates are a notable exception.

The war records in steel plate export are represented by 551,900 gross tons in 1918, while those for 1917 were 525,670 tons. These figures compare with 223,800 tons in 1913, the record before the war, and 59,500 tons in 1914. But in the first nine months of 1919 these exports were 557,900 tons, or 61,900 tons per month, which is about 16,000 tons per month, or 25 per cent more than the monthly average in 1918. These figures do not include steel sheets.

A study of the destination of American export plates also presents interesting comparisons. Japan has been by far the largest buyer and still is. The shipment of steel plates to Japan reached its climax in 1918, when 257,700 tons, orr rover 50 per cent of the total of 551,900 tons, went to that country. This was at the rate of 21,400 tons per month. Even now this phenomenal rate is being practically maintained, for up to Oct. 1, Japan had taken about 191,000 tons of steel plates this year, or 21,220 tons per month.

The second large purchaser of American steel plates is Canada. That country in 1916 took 116,500 tons, or 9700 tons per month, and this consumption has been gradually increased until the shipments to Canada in 1919 to Oct. 1 were 144,800 tons, or 16,000 tons per month, an increase over 1916 of nearly 75 per cent. France and Italy have also developed into heavy consumers. Up to Oct. 1, 1919, France had taken 60,000 tons, or from five to six times as much as in all of 1916. Italy's purchases made an even greater showing, having been 53,400 tons for the first nine months of 1919, as against only 6000 tons in all of 1916. Even China thus far this year has purchased twice as many steel plates as in the ame period in 1917. Great Britain's purchases to Oct. 1, this year, have been nine times what they were to Oct. 1, 1917.

It was hardly to be expected that the export steel plate movement would attain such proportions in the months of readjustment following the war; but the demand is explained by the world-wide destruction of shipping during the war and the effort of every country capable of building ships to fill this void as soon as possible. The statistics especially emphasize what is commonly known of the important role Japan is planning to play in the world's shipping operations.

—"Iron Age"

SHIPBUILDING NOTES

Pacific Coast

FIFTY-SIX VESSELS, TOTALLING 200,000 TONS CONSTRUCTED IN BRITISH COLUMBIA IN 1919.

The output of British Columbia steel and wooden shipbuilding yards for the year 1919 totals ten steel ships and forty six wooden vessels aggregating 170,500 tons. Contract for 65,600 tons are well on the road to completion. Four steel steamships were turned out for the Imperial Munitions Board, and six for the Canadian Government Merchant Marine. The wooden vessels were built for French, Norwegian and Greek intersts. Forty French wooden steamships, two Greek, one Canadian and three Norwegian sailing vessels were built in British Columbia yards during the year.

The following table shows the ships delivered during 1919: Steel ships: Coughlan's, Vancouver, six steel ships of a total of 51,400 tons.

Wallace Shipyards, Vancouver, four ships of 18,800 tons.

Wooden Ships.

Foundation Company, Victoria, twenty French steamships of 3,000 tons each, total 60,000 tons.

Cholberg Ship Company, Victoria, three Norwegian sailing vessels, of 1,500 tons each, total 4,500 tons.

Lyall's, North Vancouver, eight French ships 1,500 tons each, total 12,000 tons.

Northern Construction Co., Vancouver, five French ships, total 7,500 tons.

New Westminster, five French ships, 7,500 tons.

Pacific Construction, Coquitlam, two French and two Gréek, 8,600 tons.

B. C. Marine, Vancouver, one steamer, 500 tons.

Summary.

Steel, 70,200 tons.

Victoria, wood, 64,500 tons.

Mainland, wood, 36,100 tons.

The Coughlan yard has two 8,100-ton steel ships to complete for the Canadian Government Merchant Marine. The Wallace yard has launched an 880-ton steel ship for the Union Steamship Co., and has contracts for two 8,100-ton steel vessels for the Government.

The Harbor Marine Company, Ltd., of Victoria, is engaged on two 8,100-ton ships for the Government fleet, and the Prince Rupert Drydock and Engineering Co. is building two 8,100-ton ships, also for the Canadian Government.

FOUNDATION COMPANY DISMANTLING SHIPBUILDING PLANT AT VANCOUVER, B. C.

The dismantling of the great shipbuilding plant of the Foundation Company, delayed for weeks in the hope that further contracts might be secured, will commence forthwith, instructions to that effect being yesterday received from Manager E. E. Jenkins, now in New York.

Mr. Jenkin's telegram authorizing the final demobilization of the equipment is as follows: "No further need holding up dismantling of plant. Proceed to get everything cleaned up and out of the way. Extend season's greetings to force. Leave here December 26 for Seattle."

Local officials of the Foundation Company were not at all agreeable to the proposal of the Dominion Government that the company should undertake the construction of four small lumber schooners. This opposition was based mainly on the grounds that the operations are not sufficiently extensive to provide employment for even a small percentage of the many men whose interests the company had in mind when it made its proposal to build wooden steamers here and take them over on completion, if financial aid during the construction period was forthcoming from the Dominion Government.

It is understood that the valuable equipment now located at the Ogden Point assembly plant will be crated and stored at the shipyards at Point Hope, where the lease from the Provincial Government has a much longer life than that governing the tenancy of the Dominion property at the Outer Docks.

GOVERNMENT TO OPERATE STEAMER ON PACIFIC COAST.

A rumor that the Canadian Government is about to build a fleet of coasting vessels to operate on the Pacific has been officially confirmed by C. C. Ballantyne, Minister of Marine.

The Government, said Mr. Ballantyne, has lately taken over the Canadian National Railway and intends to build up a big merchant marine connnecting with the railway terminal at Vanvouver. Tenders will be called for immediately so that construction may begin by January 1 of two steamers for the triangular run between Vancouver, Seattle and Victoria. These vessels will be fifty feet longer and at least three knots faster than the Princess Victoria and Princess Charlotte, now on the route for the Canadian Pacific Railway.

The Government expects to pay about $1,000,000 each for these vessels. The Princess Charlotte was built in England séveral years before the war and cost $600,000, and has a speed of about twenty knots.

These vessels will have their terminal at a new Government wharf to be contructed here. Plans for pier and steamers are being discussed by the Minister of Marine and the Vancouver Harbor Commissioners who have gone to Ottawa for the conference.

As already announced, the Government plans to put new cargo carriers on the Pacific, both to Oriental and Australian ports. Mr. Ballantyne said he hoped soon to announce that five passenger liners would be put on these routes, and a combined freight service between this city and Ceylon, Calcutta and Singapore inaugurated.

The first of the four boats to be put in the water to the order of the Canadian Government by the Coughlan Shipyards was launched on Dec. 6th and christened by Mrs. R. C. Cooper, wife of the Federal member for South Victoria.

The Canadian Importer, which is an 8,000-ton steamer, will be the first vessel of the Canadian Mercantile Marine to go on regular service between Vancouver and Australia with general cargo. Although it will require several weeks to equip the vessel, Acting Superintendent Brostede expects to have the vessel away in about a month. Fully 75 per cent of the space has been taken.

GREAT LAKES AND MARITIME.

On Dec. 20th another steel ship was launched in Toronto by the Dominion Shipbuilding Company. The vessel, which was named after the Mayor of Toronto, was christened in the time-honored way by Mrs. Lionel Clarke, wife of the Lieutenant-Governor of Ontario, the ceremony being attended by the Lieutenant-Governor, Mayor Church, Miss Church and officials of the Company, together with many other invited guests. The T. L. Church'', a steel cargo freighter designed for trans-Atlantic service, was built by the Dominion Shipbuilding Company for their own interests and is 261 feet in length, with a moulded depth of 22 feet 11 inches and moulded breadth of 43 feet 6 inches. She is equipped with triple expansion reciprocating engines of 1200 horsepower and has a dead weight carrying capacity of approximately 3350 tons gross. A sister ship of this type will be launched the latter part of this month making a total of nine vessels launched this year from the yards of the Dominion Shipbuilding Company. Six of these have been completed and delivered during the past six months at the rate of one ship per month.

The steamer Chicora of the Canada Steamships Lines, believed to be the oldest steamboat in existence on the Great Lakes, sprang a leak a few days ago and foundered, snapping her cables as she sank and swinging bow first into the channel.

In her early days the Chicora, one of the fastest and most beautiful vessels of her time, participated in many interesting events in the history of both Canada and the United States.

According to the publication, ''A Century of Sail and Steam on the Niagara River,'' by Barlow Cumberland, she was built at the time of the American Civil War by ''Lairds,'' Livevrpool, being originally christened the ''Let Her Be.'' Her sister were ''Let Her Rip'' and ''Let Her Go,'' constructed for the purpose of running the blockade which the United States had placed on the ports of the south. Her builders are quoted as saying that she had an unusually strong frame and would be worth replating should it ever be desirable to do so. (This was largely done at the Kingston drydock in the winter of 1904, at an expense of $37,00.)

Once in commission the ''Let Her Be,'' under the ownership and command of Capt. Geo. Boynton, plied between the British port of Turk's Island, in the Bahamas, and the blockaded Southern city of Charleston, S. C. On one notable trip on this route she was spotted by the lookout of one of the patrol boats of the blockading squadron which had been strengthened, unknown to Capt. Boynton.

In 1868, having been renamed the Chicora which is said to be a word of Spanish-Indian origin, meaning ''The Pretty Flower,'' she was brought up from Halifax by N. Mulloy & Co. of Niagara to increase the service to Lake Superior.

Two years later, in 1970, she was again called into war service, this time to transport troops and stores from Collingwood to the point on the shores of Thunder Bay where the expedition for the suppression of the Reil rebellion was landed. Difficulties were experienced at first, as the only lock by which vessels could pass from the level of Lake Huron to that of Lake Superior was owned and controlled by the State of Michigan. Several cargoes of supplies, as well as companies of troops, had to be disembarked at the Canadian Sault and portaged across to Port Aux Pins on the Canadian side above the rapids, where they were picked up by another boat and taken to their destination on the north shore.

On May 21, 1870, she sailed from Collingwood with Col. Garnet Wolseley (later Viscount Wolseley) and a detachment of the ''60 Rifles'' of the Regulars (the regiment of H. R. H. Prince Arthur) and the balance of the expedition. This time as before the soldiers and supplies were unloaded and portaged across, but the Chicora passing through the canal empty, reloaded her troops and their equipment and carried them to the landing port.

In the year 1874 the Chicora again gained distinction by being chartered as a special yacht for the use of Lord Dufferin, then Governor-General, on a tour through Northern Ontario (of those days) and the Upper Lakes.

A further step in the expansion of the ocean traffic of the Canada Steamship Company was announced in the statement that another steamship of 9,000 tons displacement, has been acquired for service between New York, the West Indies and South America. The U. S. steamer Shoshone was purchased from New York people and its name is being changed to that of ''Manoa.'' The Shoshone was built in Germany in 1913, for the South American passenger trade, and was taken over by the United States Government at the begining of hostilities, the vessel being at that time in the port of St. Thomas, West Indies. The dimensions are: Length, 352 ft.; beam, 48 ft.; depth, 27 ft. The steamer is being thoroughly overhauled and fitted throughout, and will have accomodation for 125 first class and 100 third-class passengers, and will also carry about 4,500 tons of cargo. The Manoa will be one of the most luxurious vessels in the trade, and will sail from New York on her first voyage on the 10th of December. It is expected that another steamer of the same type will be added to the fleet within a month. The fleet now includes the steamers Manoa, Guiana, Parima and Korona.

The announcement has been made by Baines & David, Limited, iron and steel merchants of Toronto, that they are carrying on business without interruption in the same premises formerly occupied by Baines & Peckover, 98-116 Esplanade E., and the warehouse at Eastern Harbor Terminals.

The firm is old established, one of long standing, the company having been started by Mr. R. A. Baines in 1884. In 1906 Mr. W. M. David, who had a life-long experience in the iron and steel business, became connected with the firm and for some years past was Sales Manager. Several weeks ago he became a partner with Mr. Baines and the firm name has been changed to Baines & David, Limited.

British Blast-Furnace Slag in Concrete

Strength Slag Aggregate—Experience in England—British and American Slags Compared

The use of crushed and screened blast-furnace slag in concrete is well known in this country and is attracting attention abroad. There are large slag dumps in the Middlesbrough district in England, and much slag is produced there every day. Dr. J. E. Stead, the well known English metallurgist, recently read a paper before the Cleveland Institution of Engineers entitled "Blast-Furnace Slag in Concrete and Reinforced Concrete." The concrete foundations of very many large buildings and of machinery in that district have crushed blast-furnace slag as the aggregate, and wherever it has been necessary to remove such foundations no deterioration or disintegration has been found.

British Examples of Slag Concrete

The great breakwater at the mouth of the River Tees at South Gare is in part constructed of slag concrete and stands as a monument to the value of slag as the aggregate in concrete. Huge slag concrete blocks have to be periodically placed round about the end of the pier to break the force of the waves. These are rolled about and in time get ground down by sheer attrition. Specimens from these blocks varying from 6 to 17 years in use show no evidence of disintegration. The particles of slag aggregate are as sound as the binding matrix.

Another sea pier is the one at the plant of the Skinningrove Iron Co. finished in 1891, which was constructed of a concrete consisting of fine granulated slag and 25 per cent slaked lime, sand from the beach and crushed slag as the aggregate. Samples broken off below high water mark show the concrete to be in good condition. One piece contains a lump of slag firmly cemented to the matrix, the corners of which are quite sharp. The concrete is almost as good after 30 years' exposure as that taken from the large blocks after weathering 17 years.

Crombie & Son of Middlesbrough has had more experience in the use of slag than any other firm in the district. Their annual average amount of crushed slag used in concrete for the 10 years up to 1914 has been about 10,000 tons. Quite recently they made 50 miles of reinforced covers for electric cable channels, with crushed slag as the aggregate. Since the war reinforced concrete pit props have been made by them, also many of the buildings at the new coke ovens at the Redcar Iron Works are constructed of slag aggregate reinforced concrete. In addition they have supplied all sorts of reinforced slag concrete window sills, ornamental house facings, stairs and landings, etc. Other concrete contractors have also used the same material in considerable quantities and it may be accepted that in the Middlesbrough district the use of reinforced slag concrete for almost every purpose is firmly established.

In the discussion of the paper Mr. Crombie stated that in 40 years' experience he had never found deterioration of steel in concrete. The best slag concrete he makes had been obtained from Cleveland ironstone slag and Portland cement containing only about 30 per cent lime. He specializes in floors and erection work where it is essential to have a hard aggregate and the best aggregate is clean slag free from dirt and scale, and by preference slag run into ladles and allowed to cool before tipping. Tests have shown slag concrete to stand nearly 40 per cent more strain than whinstone concrete.

British and American Slags Compared

Dr. Stead reviewed the recent literature on the subject paying great attention to the papers and reports published in the United States. The analyses of the Cleveland hematite slags approximate very closely in composition those produced in our furnaces smelting Lake ores. The slags obtained from smelting Cleveland ironstone, owing to their high content of alumina and magnesia and low proportion of lime, have never been known to disintegrate on exposure to air and rain, and for that reason are at all times (whether weathered or not) perfectly suitable for concrete making. It is safe to use the slag as soon as it cools. Slag balls which have been exposed to the weather for 50 years show no signs of disintegration. The hematite slags do not disintegrate except when the lime is increased to 50 per cent, but at that point they spontaneously disintegrate soon after they become cold. This is a phenomenon not due to weathering or the absorption of water of carbonic acid from the air, but to a remarkable physical change of some of the slag constituents. the molecules become rearranged and the mass simply falls to powder. It is this tendency of such slags to disintegrate which has led civil engineers to prescribe for concrete construction well-weathered material.

It may be taken as proved that hematite slags which have been weathered for six months or more and have not fallen to powder are quite suitable for concrete construction.

Greater Strength of Slag Aggregate

A very interesting section of the paper is devoted to the question why blast-furnace slag aggregate makes stronger concrete than other aggregates. This has been found to be true here as the result of careful research. Dr. Stead's explanation is that all crushed blast-furnace slags, excepting perhaps the siliceous slags from charcoal furnaces, on being exposed to moisture or liquid water become more or less hydrated on the surface. That such is the case has been proved by careful examination of the aggregates of slag separated from very old concrete, and from slags removed from situations where they have been constantly damp for years. It is also proved by exposing finely powdered slag to water for even 14 days, for they chemically fix water in that short time. Some examples of this are given in the accompanying table.

There can be little doubt that finely powdered slags would, in moist situations, chemically combine with a considerable quantity of water. The more lime present the more readily does hydration occur, for calcareous slag in powder behaves almost like Portland cement and soon becomes hydrated when it is mixed with water. Lumps of cement hydrated and if used as an aggregate in concrete with finely powdered Portland cement would make a very strong coherent mass, for the hydrated surface layers of the aggregate would crystallize together with the fine cement covering

them. As the pieces of slag become superficially hydrated in concrete the surrounding cement will equally crystallize with the hydrated surface layers and produce a strong junction.

Effect of Exposing Powdered Slag to Water

	Combined water, Per Cent
Outside layers, ¼-in. pieces old slag	0.60
Inside portions, same pieces	0.20
Outside layers of small pieces slag aggregate from concrete, South Gare Break water, exposed at least 30 years	1.20
New slag in fine powder after being kept moist 14 days	0.35
Slag sand made by running liquid slag into water	0.20
The same slag sand after being moistened with water 14 days	0.55
The same slag chilled on an iron plate, powdered and moistened for 14 days	0.32
Slag brick concrete, Wood-Bodner process, after weathering 6 mo.	9.50
The same after exposure in a wall for at least 30 years	12.55
Limestone, whinstone and granite in powder after keeping moist for 14 days	Nil

The weight required to crush pebbles and whinstone is greater than for average blast-furnace slag, and as the surfaces of the natural rocks and pebbles do not readily become hydrated the union between their surfaces and the surrounding cement when together in concrete is not as great as it is with slag and cement. Therefore, the slag concrete is the stronger.

In Dr. Stead's experience the difference between the strength of the points between cement and slag on the one hand and cement and pebbles on the other, in broken ancient concrete which had been made with a mixture of slag and pebbles as aggregate, is that the fractures pass round the smooth surfaces of the pebbles but always through the slag and never at the joints.—G.B.W.

STEEL SHIP-PLATES AND SHAPES REQUIRED IN NORWAY. POSSIBLE OPENING FOR CANADIAN STEEL.

Canadian merchants have been instituting inquiries in Norway as to the prospects for their steel products. Apparently the conclusion has been reached that the chief opening lies in the construction in Norway of trawling vessels. Up to the present time trawlers have not generally been used by Norway on account of a slow and conservative method of adopting new schemes. The use of such vessels at the present time, however, is on the increase, and up to the present a few boats under 100 tons have been purchased and equipped. These steam trawlers have been put into operation and have proved so satisfactory that at the present time Norwegian shipyards are crowded with orders. Some of the companies claim that they have contracts which will keep them busy for the next four or five years. One difficulty lies in the way, however, regarding the scarcity of steel. Quite a few orders have been placed in England, but that market is unable to take full advantage of the offerings made, and a larger part of the business is going begging. Herein lies the chance for the Canadian steel companies. The two important points that Norwegian trawlers operate frorm the Aalesund and Christiansund.

—Financier & Bullionist, London.

UNITED STATES INTERESTS TO CONTROL RAW MATERIALS FOR FERRO-ALLOYS

Vanadium Corporation Purchase Primos Chemical Co.

N. Y.—J. L. Replogle, president of the Vanadium Corporation of America, has announced acquisition of the properties of Primos Chemical Co. Vanadium Corporation will issue 93,334 shares of new stock, to be offered to stockholders at $45, to finance the purchase. Mr. Replogle's statement says:

"Negotiations which have been going on for some time for the purchase of the Primos Chemical Co. by the Vanadium Corporation of America, were completed Saturday, and the Vanadium Corporation of America takes over the control and operation of the Primos properties Jan. 1, 1920.

"The Primos Co. are producers of vanadium, molybdenum, tungsten, and other alloys, having valuable deposits of these elements in Colorado, and a very large refining plant at Primos, Delaware county, Pa., near Philadelphia.

"The molybdenum property is one of the largest, if not the largest mine of this kind in the world, and in view of Professor Arnold's discovery of the new 'super steel,' which was widely discussed by the press within the last few weeks, property is considered to be very valuable if Professor Arnold's process is generally adopted. Professor Arnold's invention is merely a departure from the universal use of tungsten in high speed steel, and a substitution of about 6% molybdenum and double quantity of vanadium generally used. A wide use of this steel, which is anticipated by crucible steel manufacturers, would enormously increase demand for vanadium and molybdenum, which naturally would be of very great benefit to the Vanadium Corporation of America, which controls large deposits of vanadium, molybdenum and other ores for steel alloys.

"The acquisition of this property is in the line of expansion by the Vanadium Corporation of America, which expects to make practically all alloys for steel manufacture. It is quite likely that they will also go extensively into the manufacture of ferro-manganese, the ore for which will be imported from Brazil, India and Russia.

"To provide for purchase of the Primos plant directors of the Vanadium Corporation of America Monday voted to issue 93,334 shares of additional stock, which will be offered to stockholdders at $45 per share; the entire issue has been underwritten by Allan A. Ryan and associates. This will give present stockholders of the Vanadium Corporation of America value of rights giving them one (1) share of additional stock at $45 for each three (3) shares of stock now owned by them."

Vanadium Corporation, it is learned, has not acquired the stock of the Primos company, but all its plants, mines, good-will and other assets, tangible and intangible.

Earnings of the Primos company in the past three years are understood to have averaged slightly under $1,000,000 annually after taxes.

Col. Merrill G. Baker, vice-president of the American Vanadium Corporation, recently returned from an extensive inspection trip over the company's property in Peru. Vanadium Corporation recently purchased some caterpillar tractors to hald ore and is carrying out engineering work which will greatly increase the production of vanadium ore.—Boston News Bureau.

BOOK REVIEWS.

INDUSTRIAL FUELS, by J. Stephenson. Published by the Westman Press, Ltd., 72 Queen St. W., Toronto. 190 pages, 107 drawings. Paper backs \$2.25, Cloth \$3.00. 9¼ by 6 inches.

The author of this comprehensive brochure is also the author of "Elements of Water Gas", of which a second edition is in preparation, and is with the United Gas & Fuel Co. of Hamilton, Ont. As is stated in the preface, the scope of the subjects treated is unusually broad, but for executives who have the choice of several fuels and desire to make quick comparisons, the book affords a concise survey of all the better known and some of the lesser known fuels that are adapted to industrial uses. The fuels treated on include coal, natural gas, coal gas, oil gases, producer gases, coke, and fuel briquets.. The application of gases as commercial sources of fuel is fully dealt with, and a chapter is devoted to fuel analysis. The concluding chapter deals with fuels of the future, including domestic garbage, and alcohol, the possible sources of fuel alcohol being enumerated.

A perusal of the work reveales an astonishing variety of fuels available for industrial uses, but we believe the most important indication afforded by the author's survey of a varied field is that the fuel of the future will tend more and more to be used in a gaseous state, or in the condition that most closely approximates to the gaseous state, namely, dust fuels, allowing an intimate admixture during combustion with the oxygen of the air and consequently approximately complete combustion.

"Iron & Steel" is pleased to be able to review a work of this nature, written and published in Canada, and takes this opportunity to congratulate the author and the publisher thereon.

ASBESTOS, and the Asbestos Industry, by Leonard Summers, 5 ins. by 7 ins. Cloth, 107 pp. with index. Illustrated. Price 2s. 6d. Sir Isaac Pitman & Sons, London and New York.

The users of asbestos are today very varied, and enter largely into the equipment of workmen employed in manufacturing processes where great heat is experienced, and this little volume, which is the latest addtion to Messrs. Pitman's series of treatises on "Common Commodities and Industries", lists a surprising number of modern uses of asbestos. These include steam packings and pipe jointings, boiler insulating materials, fire-proof paints, theatre curtains, building materials, roof coverings, portable houses, lamp wicks, miner's safety-lamp gaskets, cord and twine, fire-ladders and ropes; protective clothing for furnacemen, such as leggings, spats, aprons, gloves, twine, fire-ladders and ropes; protective clothing, for asbestos-soled boots, heat screens, helmets, etc. Various forms of electric insultation, fireproof asbestos papers, and many other applications in modern industrial arts are mentioned for this extraordinary mineral. An interesting mention, to Canadians, is that Canadian asbestos comes first in quality and tonnage produced of all countries.

ELECTRIC MINING MACHINERY: by Sydney F. Walker, author of "Electricity in Mining." Isaac Piltman & Sons, Ltd., London and New York. Cloth, 8 by 5½ ins., 374 pp. with index. Illustrated. 12/6 net.

Mr Walker's work on "Electricity in Mining" was one of the pioneer works on the application of electricity to mining operations, and a comparison between the new work now issued by Pitman & Sons and the earlier book will show what great strides have been made. Mr. Walker, in the preface, writes, with correctness, that electric science advances day by day, and that it is impossible to be quite sure that everything which is on the market has been included in his book. Mr. Walker also urges the importance of employing competent electrical engineers in mine plants where large use is made of electric machines. and pleads for a recognition of the necessity to pay adequate salaries if employers are to obtain the services of really competent electricians. As all mining engineers know, to their sorrow, there are electricians and electricians. Modern electrical machinery is above all efficient. If electrical engineering applied to mining has a fault, it is in the tendency of manufacturers to take undue advantage of the nice calculations which are possible in electric machine design, and not to make sufficient allowance for the special conditions under which mining machinery must operate. This tendency makes the employment of competent electricians all the more necessary.

The book discusses the merits of various prime movers, favoring the steam turbine in general, but going fully into the use of gas producers and gas engines where the presence of suitable materials, or waste gases, indicate economy in the use of this form of primary power.

The lay-out of an electric generating station for a group of mines is explained, as also a suitable layout for a single mine.

The principles and design of modern electric generators and machines is made the subject of a number of chapters, and much attention is paid to the problems of transmission, the regulating of pressures and the use of measuring instruments, which Mr. Walker intimates, mine operators have shown some backwardness in installing.

Especial attention is devoted to the insulation and support of mine cables, a matter of very great inportance under the conditions of strain and damp surroundings that transmission cables in mines are often subjected to. Mr. Walker mentioned that aluminum is coming into favour as a conductor metal as the quantity manufactured is increased, because of its lightness. The question of weight in mine cables is important, where these have to be led down vertical openings, and require strong support.

The subdiary uses of electricity are gone into in individual chapters. The chapter on portable electric mining lamps does not include any references to to cap type of lamp with Edison battery that is now so largely used on this side, and mentions that the hand lamp of the Ceag type is regarded as the standard in British practice. Electric winding, or what is known as electric hoisting in North America, is described, as are also the forms of electric haulage used underground. The great adaptability of electricity to the operation of secondary or auxiliary haulages is pointed out.

MINERAL DEPOSITS OF SOUTH AMERICA: By Benjamin L. Miller, Professor of Geology, Lehigh University, and Joseph Singewald, Assoc. Prof. of Economic Geology, John Hopkins University. First Edition. Cloth. 6¼ by 9¼ inches. 598 pages with Index and Bibliographies. McGraw Hill Book Co., New York and London.

This work fulfils the intention of its authors to "fill a genuine want in the literature of economic geology" and is the outcome of an extended trip made by the authors in 1915. The idea of publishing the observations made on this journey in book form is well justified by the volume now presented, for not only have the authors assembled in handy form a great deal of information regarding an immensely wealthy but little known half-continent, but they have added to each chapter that deals with the individual countries, a detailed bibliography that adds greatly to the value of the work.

The volume is too well digested and contains too large a mass of information to permit of covering the ground in a short review, but iron and steel men will be much interested in the description of the large deposits of iron-ore and manganese which occur in Brazil, chiefly in the State of Minas Geraes, and are concentrated around the peak of Itabira. The authors quote Harder's estimate that the Central Mines Gereas region, roughly 100 miles square, contains in the thirty known deposits 410,000,000 long tons of Bessemer ores with over 69 per cent iron and less than 0.02 phosporous, and almost three billion long tons of non-Bessemer ores with over 50 per cent iron and 0.05 to 0.3 phosporous. The authors state that without doubt Brazil contains "the most extensive undeveloped deposits of iron ore of any country in the world".

With reference to manganese, it is stated that during the first years of the European war the steel industry of North America was almost entirely dependent upon Brazilian manganese ores, and it is probable that even after the close of the war North America will continue to look to Brazil for a considerable part of its manganese ores. The authors say: "It is questionable "whether any country in the world possesses greater "deposits of manganese ore than does Brazil, so that "we confidentially predict that the Brazilian man-"ganese industry is bound to increase steadily in importance. No other country, certainly, with the exception of Russia and perhaps India, at the present time, seems to offer more promise in the way of exploration for workable manganese ore bodies."

The mention of Brazilian iron ores is of particular interest to Canadians, as at one time, if not now, one of the large steel companies in Canada held some extensive options on deposits near Itabira.

An interesting reference is made to the Minasragra Vanadium Mine near the Hauraucaca Smelter in Peru, now owned by the American Vanadium Company, which since its discovery is said to have furnished 80 per cent of the world's demand for vanadium.

The Moro Velho Mine of the St. John del Rey Mining Company, at Villa Nova de Lima in the State of Minas Geraes, Brazil, is described as the most interesting mine in South America, and in some respects the most remarkable in the world. The mine, which operates for gold, which has been operated by an English Company since 1834 without serious interruption.

The mine claims the world's record for depth, workings being on August 24th 1917 at a depth of 6,126 ft. below the surface. It is stated that it can probably be worked—if the ore retains its value—to horizon 26, which would give a vertical depth of 7,626 feet, and even to a much greater depth.

The authors remark that the persistence of the ore-body and the absence of any material change in the tenor of the ores with depth are of especial interest "as both are in disagreement with ideas commonly held by mining men."

It is interesting to note, in connection with the depth of the mine, that the surface has an elevation of 2,774 feet above sea-level.

South America appears to be extremely rich in metals, but the coal deposits are unimportant, except in Chili where there is an interesting extension of the coal seams under the ocean near Conception Bay, where mining has been carried on since 1840.

It may well be that Drs. Singewald's and Miller's work will see future additions as the knowledge of South American mineral deposits is added to.

IRON DEPOSITING BACTERIA AND THEIR GEOLOGIC RELATIONS; by Edmund Cecil Harder. Professional Paper No. 113, U. S. Geological Survey. 1919.

While this professional paper is extremely technical it is not without interest even to those who do not possess the wide knowledge of chemistry and bacteriology that is necessary to its full understanding. In the preface, by F. L. Ransome, it is stated that since 1836, it has been known that certain bacteria have the power of withdrawing iron from solution, and causing its precipitation as ferric hydroxide. "The precipit-"ation of iron sulphide by bacterial processes has also "been known for some time. The geologic application "of these discoveries, though predicted by some to be "far-reaching, have been rather slowly made, and it is "safe to say that many geologists have paid little "attention to the possible extent of bacterial action in "the deposition of iron ores."

Dr. Reinhardt Theissen recently, in a paper before the A. I. M. & M. E., referred to the part possibly played by the so-called "sulphur bacteria" in the formation of the sulphur that is present in coal (see Iron & Steel, November issue, page 283) and it is stated also by Mr. Ransome that the part played by bacteria in the deposition of limestones has been specially investigated and found to be important.

While the actual utility to the bacterial organism of the iron particles that it concentrates is not ascertained, it appears quite certain that large bodies of iron-ore have been formed entirely through the activity of bacterial deposition. Mr. Harder's conclusions are that in general it was found that iron-precipitating organisms were present wherever iron-bearing waters occur, both underground in wells and mines, and in surface waters. It was found that the ocherous scums which occur in such localities consisted mainly and in many places entirely of iron-precipitating organisms, of their remains. It was also found "that solu-"tions of certain iron compounds when inoculated "with almost any type of natural water or of soil, "showed a precipitation of ferric hydroxide by cer-"tain types of lower bacteria, thus indicating the al-

most universal presence in nature of organisms capable of precipitating iron from solution.''

We recollect, as a boy in the mine, seeing in a quiet air-course, a small lake of blood-red, almost cardinal coloured ''ochre'', which was made more conspicuous because it occurred in the midst of long needles of a saline efflorescence upon the white shale side of the air-course. The consistency and appearance of this cardinal lake corresponds exactly with the results of the work of the bacteria described by Mr. Harder.

Among the iron-ore deposits classified as being originally laid down mainly as ferric hydroxide are included the Wabana ores in Newfoundland, and our readers will recollect a paper which was delivered by Dr. A. O. Hayes of the Canadian Geological Survey, and summarised in ''Iron & Steel'' of August last (see page 176) wherein slight reference was made to the probably bacterial origin of these vast deposits.

The A. B. C. of Iron & Steel: The Penton Publishing Company, Cleveland, Ohio edited by A. O. Backert. Third Edition. Cloth. 8 by 11 inches by one inch. 374 pages with Directory and Index. Price $5.00.

This book epitomizes the technique and business extent of the iron and steel industry of the United States, and contains a series of chapters, each written by an authority in his particular specialty, on various branches of the industry, commencing with the mining of the iron-ore, dealing fully with transportation and fuel supply, with the basic processes of iron and steel manufacture, and with all the branches of fabricated steel. Chapters are included on malleable iron, steel castings and electric steel.

The book also contains statistics of the American iron and steel industry, and a complete directory of tion and fuel supply, with the basic processes of iron the iron and steel works of the United States and of Canada, classified by firms and also by products. A complete index is attached.

The book is printed on fine stock and the illustrations are numerous and good. The article on Transportation of Ore on the Great Lakes contains a number of historical photograph showing how the transportation facilities of the Great Lakes have developed from small schooners of 15 to 20 tons burden to the great 10,000 ton freighters that are now used.

This book should be of considerable utility to all who have occasion to do business with the steel industry, and to advertisers of steel plant equipment.

Mc LAIN-CARTER OPEN-HEARTH FURNACE

The Mc. Lain-Carter Furnace Company of Milwaukee, Wis., issued a well-illustrated and informative catalogue describing results obtained from their open-hearth furnace, which is designed to suit the needs of foundries and other metal-working establishments making high-grade steel castings. The furnace is built in capacities of from two tons to twelve tons, and it is by the same makers that this type of furnace will give high temperatures with long-life of roof and side walls, and will make steel of sufficient fluidity to pour the smallest casting. The furnace is designed primarily for oil-firing, and the use of fuel oil is recommended. Foundrymen will find this catalogue interesting reading.

APPROXIMATE PRODUCTION OF IRON AND STEEL IN CANADA DURING 1919.

JOHN McLEISH
Dept. of Mineral Statistics, Ottawa.

Canada's metallurgical industry in iron and steel has become an important factor in our industrial situation, but has been based very largely upon imported ores, a situation which has not been materially altered by the war. A comparatively small production of beneficiated iron ores continues to be obtained from the siderite deposit at Magpie, and from the magnetites at Moose Mountain.

The total shipments of iron ores from Canadian mines in 1918 were only 211,608 short tons and probably about the same tonnage will have been shipped during 1919, the two properties above mentioned being the principal ones that have been operated.

The production of both pig-iron and steel has been less than in 1918, when the total production of pig-iron was 1,195,551 tons (of 2,000 pounds) and of steel 1,873,708 tons (of 2,000 pounds.)

The estimated production of pig-iron in 1919 is 920,000 tons, a falling off of about 23 per cent, and the production of steel ingots and castings is estimated at 1,020,000 tons, a decrease of about 45 per cent.

In 1918 pig-iron was made in electric furnaces from scrap steel to the extent of 32,031 tons. The corresponding production in 1919 was probably less than 8,000 tons. Electric furnace steel production in 1918 was 119,130 tons. It is doubtful whether the 1919 production reached 15,000 tons.

In Nova Scotia the blast furnace of the Nova Scotia Steel & Coal Co. was closed down toward the end of June and was not reblown until after the middle of November. All furnaces of the Dominion Iron & Steel Co. were closed down in August and remained down until late in October. In Ontario the furnaces were somewhat more active, the Steel Company of Canada at Hamilton havving all furnaces in blast at the end of September. The Algoma Steel Corporation had two furnaces active and two closed down, and the Canadian Furnace at Port Colborne was active. The Deseronto furnace was closed down in June, the Midland furnace in August and the Parry Sound furnace in September, all remaining down for the balance of the year.

METALLOGRAPHIC APPARATUS

We have received from Holz & Co., Inc., of New York, Bulletin 22-23, giving particulars of the latest type of photo-micrographic and macrographic apparatus manufactured by this house. The Bulletin gives some useful information regarding the optical principles of the microscope as applied to metallography, and concerning methods of determining grain sizes. This firm also sell metallographic grinding machines, of the endless belt type, and other accessories for polishing an dpreparing specimens for microscopic examination.

Index to Mill Supplies

This Directory is published in the interests of our readers. Buyers who are unable to find out what they desire are invited to communicate with the publishers of this Journal, who in all probability, will be able to give the desired information.

Abrasive Materials:
Canadian Fairbanks-Morse Co., Montreal, P.Q.

Accumulators, Hydraulic:
Canadian Fairbanks-Morse Co., Montreal, P.Q.
Smart-Turner Machine Co., Hamilton, Ont.

Air Compressors:
R. T. Gilman & Co., Montreal.

Aluminum:
Canada Metal Co., Toronto, Ont.
A. C. Leslie Co., Ltd., Montreal.

Automatic Scales:
Canadian Kron Scale Coy., Montreal.

Axles:
United States Steel Products Co., New York.

Axles, Car:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.

Axles, Locomotive:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.

Ball Bearings:
Canadian Fairbanks-Morse Co., Montreal, P.Q.

Babbitt Metal:
Canadian Fairbanks-Morse Co., Montreal, P.Q.
Canada Metal Co., Ltd., Toronto, Ont.
Frankel Bros., Toronto, Ont.
Wilkinson & Kompass, Hamilton, Ont.

Barrel Stock (Black Steel Sheets):
Seneca Iron & Steel Co., Buffalo, N.Y.

Bars:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
United States Steel Products Co., New York.

Bars, Iron & Steel:
Baines & Peckover, Toronto, Ont.
Manitoba Rolling Mill Co., Winnipeg, Man.
Canadian Western Steel Co., Calgary, Alta.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Ferguson Steel & Iron Co., Buffalo, N.Y.
The Steel Company of Canada, Hamilton, Ont.
Beals, McCarthy & Rogers, Buffalo, N.Y.
Burlington Steel Co., Hamilton, Can.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.
Canadian Drawn Steel Co., Ltd., Hamilton, Ont.
Canadian Tube & Iron Co., Ltd., Montreal.
Leslie, A. C. & Co., Ltd., Montreal.
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto.
Wilkinson & Kompass, Hamilton, Ont.

Bars, Steel:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.

Belting:
Main Belting Co., Ltd., Montreal.

Billets and Blooms:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.

Belting, Chain:
Canadian Fairbanks-Morse Co., Montreal, P.Q.

Belting, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.
Wilkinson & Kompass, Hamilton, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

Belting, Transmission, Elevator & Conveyor, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Benzol:
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.

Binders Core:
Hyde & Sons, Montreal, Que.

Bins Steel:
MacKinnon Steel Co., Ltd., Sherbrooke, Que.
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto
Toronto Iron Works, Toronto, Ont.

Black Steel Sheets:
Seneca Iron & Steel Co., Buffalo, N.Y.

Blooms & Billets:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.
Dominion Iron & Steel Coy., Ltd., Sydney, N. S.

Boilers:
Sterling Engine Works, Winnipeg, Man
R. T. Gilman & Co., Montreal.

Bolts:
Baines & Peckover, Toronto, Ont
Steel Co. of Canada, Hamilton, Ont.
Wilkinson & Kompass, Hamilton, Ont.
Canadian Tube & Iron Co., Montreal, P.Q.

Bolts, Railway:
Nova Scotia Steel & Coal Co., Limited, New Glasgow, N.S.

Bolts, Nuts, Rivets:
Canadian Tube & Iron Co., Ltd., Montreal.

Boiler Compound:
Beveridge Paper Company, Limited, Montreal.

Boiler Covering:
Beveridge Paper Company, Limited, Montreal.

Box Annealed Steel Sheets:
Seneca Iron & Steel Co., Buffalo, N.Y.

Brass Founders:
Canada Metal Co., Toronto, Ont.

Brass Goods:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Bridges:
MacKinnon Steel Co., Ltd., Sherbrooke, Que.

Brushes, Foundry, Core:
Hyde & Sons, Montreal, Que.

Buildings, Metal:
Pedlar People, Limited, Oshawa, Ont.

Car Specialties:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.

Carriers:
Canadian Mathews Gravity Carrier Co., Toronto, Ont.
Canadian Fairbanks-Morse Co., Ltd., Montreal.

Gaskets, Rubber:
Dunlop Tire & Rubber Goods Co., Ltd., Toronto, Ont.

Cast Iron Pipe:
National Iron Corporation, Ltd., Toronto.
Hyde & Sons, Montreal, Que.

Castings, Aluminum:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Brass:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Bronze:
Wentworth Mfg. Co., Limited, Hamilton, Ont.

Castings, Gray Iron:
Canadian Steel Foundries, Ltd., Montreal P Q
Electrical Fittings & Foundry, Ltd., Toronto, Ont.

Castings, Nickel Steel:
Hull Iron and Steel Foundries, Ltd., Hull, P.Q.
Canadian Steel Foundries, Ltd., Montreal P.Q.
The Electric Steel & Metals Co., Ltd., Welland, Ont.
Dominion Steel Foundry Co., Hamilton, Ont.
Joliette Steel Co., Montreal, P.Q.

Castings, Gray Iron:
Reid & Brown Structural Steel & Iron Works, Ltd., Toronto.

Castings, Malleable:
Canadian Steel Foundries, Ltd., Montreal P Q

Castings, Steel:
Dominion Foundries & Steel, Ltd., Hamilton, Ont.

Cement, High Temperature:
Beveridge Paper Company, Limited, Montreal.

Cement, Waterproofing:
Beveridge Paper Company, Limited, Montreal.

Cements—Plastic and Liquid:
Beveridge Paper Co., Ltd., Montreal, P.Q.

Chain Blocks:
Canadian Fairbanks-Morse Co., Montreal, P.Q.

Chemists:
Toronto Testing Laboratory, Ltd., Toronto, Ont.
Milton Hersey Co., Ltd., Montreal.
Charles C. Kawin Co., Ltd., Toronto.

Composition Ingot:
Canada Metal Co., Toronto, Ont.

Compressors, Air:
Canadian Fairbanks-Morse Co., Ltd., Montreal.

Concrete Hardener and Waterproofer:
Beveridge Paper Company, Limited, Montreal.
Smart-Turner Machine Co., Hamilton, Ont.

Consulting Engineers:
W. E. Moore & Co., Ltd., Pittsburg, Pa.
W. S. Tyler Co., Cleveland

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(Continued).

INDEX TO MILL SUPPLIES.

(Continued.)

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